Rapid technological change, increasing globalization and a changing world of employment with multiple roles during one’s professional life are necessitating a change from knowledge to learning societies. Full participation requires lifelong learning skills, meaning the ability to solve problems, work both independently and in a team, communicate effectively in all formats and on all levels, and self-direct one’s learning and professional development needs. Universities need to take responsibility in preparing students for lifelong learning. While engineering and science degrees traditionally do not emphasize the importance of lifelong learning skills new programmes of study are now being introduced, often using electronic portfolios to support engagement with learning objectives and reflection. This article describes an electronic portfolio initiative that is targeted at engineering and computer science students. The initiative aims to create awareness among students on the nature and importance of lifelong learning skills, to facilitate the development of such skills and to assist students in showcasing their competence regarding these skills. Interviews with industry representatives regarding the characteristics of a lifelong learner and the values of constructing and presenting portfolios were conducted and have resulted in strong support for the electronic portfolio initiative. The article provides background on lifelong learning and electronic portfolios, outlines the design of the initiative and then focuses on feedback from industry representatives.

Keywords: Engineering education; Lifelong learning; Portfolios; Electronic portfolios; Industry needs

1. Introduction

This article describes an ePortfolio project in the Institute of Sciences and Technology at Massey University, New Zealand. The project was initiated in 2005 in a bottom-up fashion, driven by our team of Senior Lecturers (Eva Heinrich, Computer Science; Ramesh Rayudu, Engineering; Madhumita Bhattacharya, Education). The initiative was born out of recognition of the importance of lifelong learning skills and the lack of explicit preparation our students receive in this area. We were inspired to use electronic portfolios as a tool for addressing this shortcoming from looking at the prominence of such approaches in teacher education. Our initial target group were undergraduate students in engineering and computer science. The multidisciplinary nature of our research group gave us closeness to our target programmes of study, the necessary grounding in educational theories and access to the rich level of experience in using ePortfolios in teacher education.
We are aware that a project like this, the use of ePortfolios for lifelong learning in student education, can only be successful on a larger scale with the full support of university program directors and College leaders. Our motivation was to get the ball rolling on a small scale with a localized initiative in our Institute. We wanted to provide grounding in theory, gain experience in customizing and using an electronic portfolio system, and initiate a dialogue between industry and academia. Our focus in this article lies on reporting on the feedback we have elicited from employers in industry.

2. Background

2.1 What students need to know

2.1.1 Skills required. Various terms are used in different combinations to describe the abilities, qualities and skills expected from a present day graduate who is prepared for lifelong learning in an increasingly international environment: problem solving, critical thinking, and reasoning skills; practical ingenuity; information and technology literacy; self-management skills in completing tasks on time, bringing forward initiatives and coping with change; communication, teamwork, collaboration, and leadership skills; language skills beyond first language; understanding of professional and ethical responsibilities; appreciation of human diversity, cultures and business practices; awareness of environmental impact; understanding of importance of lifelong learning and ongoing professional and personal development (Aller et al. 2005, Bouslama et al. 2003, Dowling 2006, Lohmann et al. 2006, McMasters 2006, Muffo 2001, Overton 2003, Said et al. 2004).

2.1.2 Changing degree focus. Over the last decade the awareness of the importance of ‘soft’ skills of engineering and science graduates has risen. This is reflected in the accreditation criteria for engineering degrees (Aller et al. 2005, Muffo 2001), graduate profiles and voices from industry (Davies and LeMahieu 2003, McAlister and Alexander 2003). What is emphasized is the need for looking at education in a holistic way, developing students as complete persons beyond their training in technical subject competency (Brakke and Brown 2002, Davies and LeMahieu 2003, Dowling 2006, Fallows 2003, Grabowski 2004, Hernon 2006).

Like higher education in general engineering education needs to adjust, develop new programmes, and integrate new teaching methods (Aller et al. 2005, Bouslama et al. 2003, Dowling 2006, Lohmann et al. 2006, Muffo 2001). A number of institutions have developed new programmes of study to address these challenges. Zayed University in the United Arab Emirates has developed a new educational concept, focusing on outcome based learning (Bouslama et al. 2003). Lifelong learning is encouraged through self-assessment and reflection. The University of Southern Queensland in Australia has developed a Master of Engineering Practice programme (Dowling 2006). This programme was created in context of an emphasis shift from the knowledge to the learning society, with a reversal of priorities from knowledge, skills and attitudes to attitudes, skills and knowledge. Both the programmes at Zayed University and the University of Southern Queensland use portfolios as a central tool to achieve their goals. At various universities in the United States new programmes have been created that combine engineering with language, liberal arts and international studies (Lohmann et al. 2006). Aims of these programmes include a broader multidisciplinary base of knowledge, more refined and diverse interpersonal skills, and increased language and communication skills.
2.2 Portfolios for lifelong learning in a higher education context

2.2.1 Portfolio characteristics and learning goals. The two key elements in creating a portfolio are the selection of work and reflection. The selection has to be purposeful and systematic, taking examples of the student’s own work and needs to be done by the students themselves (Linnakyla 2001). The creation of a portfolio requires the student’s active involvement in organizing, synthesizing and describing their achievements (Struyven et al. 2003). A portfolio needs to contain reflections and self-evaluations, outlining both the rationale for the selection of examples and the learning process (Linnakyla 2001). With portfolios students can showcase their academic achievements and personal growth (Bouslama et al. 2003). They can demonstrate and recognize the relationships between educational achievements, curricular and extracurricular activities (Bouslama et al. 2003). A portfolio is much more than just a collection of student work (Linnakyla 2001, Struyven et al. 2003). It gains its values from thoughtful selection, continuous self-assessment and reflection, and evaluation of process, outcome and progress of learning (Linnakyla 2001).

An ePortfolio typically starts with an opening page that introduces the author and the purpose of the portfolio and outlines the content (Linnakyla 2001). From the opening page links lead to various parts of the portfolio. Different organizational structures, for example according to subject areas or learning situations, are possible. The portfolio author should guide the reader through the portfolio material with careful selection of structure and links, attractive visual elements and thoughtful descriptions. Linnakyla (2001) reports on preferences voiced by readers of portfolios. The writing in portfolios should be brief and to the point yet still personal. Portfolios should express individuality in use of colour and graphics. Style and expression need to match the purpose of the portfolio.

Portfolios facilitate many aspects of learning. They support ability in higher-order thinking, communication and collaboration (Buzzetto-More and Alade 2006). Portfolio construction requires awareness of the audience and of personal learning needs, understanding of quality criteria and of how quality is expressed in work (Davies and LeMahieu 2003). The learning process is addressed by systematic reflection, identification of significant learning, synthesis of evidence and identification of gaps in learning (Dowling 2006). The creation of portfolios enhances writing, learning, motivation, meta-cognition and self-regulation (Linnakyla 2001). Students are required to set goals, become more aware of the interrelationship of elements contributing to their growth and are explicitly exposed to the learning outcome targets of their programmes of study (Schwartz 2006).

2.2.2 Portfolio uses. In general portfolios can be used for learning, showcasing of skills and assessment (Schwartz 2006). Often these purposes are combined. The students learn while creating their portfolios, the resulting portfolios showcase their skills and build the basis for assessment. Such combination of purposes is evident in the use of portfolios for new programmes of study as the one’s referred to earlier in this article. Beyond these general purposes, portfolios are valuable for personal development planning (Gosling 2003). Students keep a record of learning spanning formal education and life experiences. They reflect on how well their learning matches requirements of employers. Career planning and CV writing are assisted by record keeping and reflection (Gosling 2003). Portfolios are valuable tools for continuing professional development (Guest 2006, McAlister and Alexander 2003). This applies both to the actual skills development and the showcasing of these skills and will aid the process of membership application to professional bodies (McAlister and Alexander 2003). Looked at from a different perspective, portfolios can result in improved teaching, as the portfolios of a whole class enable instructors to look at a wide range of
work samples, becoming aware of the students’ capabilities and learning progress (Davies and LeMahieu 2003).

Paper-based portfolios have developed into web-based or electronic portfolios, i.e., ePortfolios. The electronic format does not change the concepts behind portfolios, but brings with it advantages in terms of a wider range of media formats, linking between entries, ease of access beyond physical constraints, and opportunities for collaboration and feedback (Linnakyla 2001).

2.2.3 Introducing portfolios into a higher education context. The introduction of any e-learning environment requires careful planning and institutional support (Kenny 2002). The same is true for the introduction of portfolio or ePortfolio programmes. Issues such as faculty buy-in, policy development, resourcing, software selection and intellectual property ownership have all to be resolved for successful programmes (Schwartz 2006). Of particular importance are the challenges faculty are facing. One danger related to the introduction of new programmes or teaching methods is that discussions are often confined to working parties and advisory groups. Individual teachers are tasked with implementations. They worry about the impact on curriculum content and their own ability to facilitate learning via the new methods (Fallows 2003). The motivation for the introduction of portfolios stems from the new emphasis on lifelong learning skills and the suitability of portfolios in nurturing these skills. Faculty must find ways to effectively integrate the new learning outcomes into courses. They must shift their focus from providing input via lecturing to giving feedback to facilitate learning (Bouslama et al. 2003). Part of the new role of faculty is to coach students towards reflection. Students, like professional engineers, are initially not aware of all the valuable learning that has occurred. They need to be prompted to reflect and taught how to recognize not just formal but as well informal learning (Guest 2006). Students must be made aware of the opportunities that lie in the development of personal and transferable skills, as they otherwise do not recognize and value these (Overton 2003). Student motivation is always an issue. Students are known for channelling their effort into tasks that provide immediate reward via marks counting towards grades. While it can be observed in general that students put less effort into portfolios if no marks are available it does occur that students are motivated by personal pride to develop their portfolios to their best abilities (Struyven et al. 2003). Scoring and grading portfolios can carry the danger of limiting the power of student choice, ownership and responsibility (Davies and LeMahieu 2003).

3. ePortfolio initiative design

As the literature shows, portfolios are often used in conjunction with assessment. New degree programmes are developed that make substantial use of portfolios (Bhattacharya 2006). In our Institute, and to our best knowledge our whole College of Sciences, portfolios for lifelong learning are not used. From our College of Education we know what effort is required to integrate portfolios in a programme of study, namely to adjust learning outcomes and assessment methods of a large number of courses and to persuade the academics involved of the benefits of these changes. Based on these observations we decided to initially position our ePortfolio initiative outside our current degree programmes and courses. This means that we offer students the opportunity to work on their portfolios independently of their courses. While we provide formative feedback the portfolios are not assessed for course credits. According to Gosling (2003) curricula should include opportunities for students to acquire skills in a risk-free environment.
There are a number of advantages to this approach. Staying outside programme structures and course credits meant that we could get underway with the project relatively quickly, as we did not have to gain approval and cooperation from programme committees and course coordinators. Independence of formal course assessment has the advantage of giving students freedom of choice and control over the direction they want to take with their individual portfolios. This is important as the students will learn more if they take responsibility instead of just responding to mandated steps. Not surprisingly, the lack of assessment pressure is linked to the biggest challenge we are currently facing in the project. It is difficult to motivate students to look beyond short-term gain.

The purpose of our portfolios is a combination of learning and showcase. We want our students to collect evidence and reflect, which will provide them with directions for lifelong learning. We want them to be able to extract selected evidence and reflections to showcase their skills when applying for employment, both for work experience placements and upon graduation. Using the literature, graduate profiles, job advertisements, feedback from colleagues and personal experiences we identified a list of skills that we see as characteristic of lifelong learning skills. By working through accreditation documents and graduate profiles we identified major subject groupings for our degree programmes. We selected the Open Source Portfolio (OSP) system (Open Source Portfolio Initiative 2006) as our electronic platform. At the centre of the OSP system lays a matrix. This matrix depicts targeted skills and subject areas and is used by students for collecting evidence, attributing it to skills and writing reflections. Within OSP scripts are setup to guide the students through the process of selecting material from the matrix and adding statements of personal philosophies and goals, to construct portfolio presentations for showcasing their skills. Figure 1 presents our initial matrix layout for a degree in computer systems engineering. Based on feedback from industry (detailed in the next section of this article) and from our students constructing their portfolios we moved towards a more generic matrix (included in figure 1). Instead of highlighting subject areas within each discipline we emphasized the places of learning, undergraduate and postgraduate studies, employment and outside activities. This set-up underlines the importance of learning outside formal university education. It is more flexible as it caters for students at different

![Figure 1. The initial matrix set-up for Computer Systems Engineering students and the modified matrix for a generic programme of study; an example for guidance given to the students. Available online at: http://eportfolios.massey.ac.nz](http://eportfolios.massey.ac.nz)
levels of study and with varied work experience. For example, a mature student with work experience before university study can now emphasize skills learnt in the workplace prominently. In the initial matrix students had difficulties identifying the matrix cell most suitable for their experience. The new layout has made this task easier.

After customizing OSP for our purposes two of our student research assistants developed their own portfolios. We used these portfolios as the basis for our discussions with industry representatives.

4. Industry feedback

In designing our ePortfolio initiative we regarded it as important to solicit industry feedback early on. We had two main reasons for this. First, we needed to ensure that our selection of lifelong learning skills matched the requirements of industry. Second, we wanted to use the statements of industry representatives regarding the value of portfolios to help us address the issue of motivating our students.

We selected six interview partners, using our own contacts and industry connections of our Institute. The six partners covered a mixture of backgrounds, small to large companies, private industry and government departments, engineering, software engineering and computing subject areas, human resource advisors and project managers. In preparation for the interviews we made our sample portfolios available. Our open-ended interview questions first asked for feedback on our selection of skills and the importance of such skills for graduate recruitment. We then covered the different sections of our portfolio design, introduction, graduate profile, personal profile and skills. We asked the interviewees on their opinions on the value of portfolios for lifelong learning and the value they might see for students in producing such portfolios. We recorded, transcribed and analysed the interviews (the quotations in the following sections were taken from the interview transcripts).

4.1 What employers are looking for in a graduate

Employers are looking for initiative and interest in the subject area and for commitment. They want to see students go beyond their study requirements. They are looking for students who have been proactive in trying out the skills learnt at university. This can be for a part-time job, for community work or just for fun. They want to see innovation and initiative, passion and curiosity. The employers see these characteristics in a student as the basis for lifelong learning.

And in particular those students, any student that shows signs that they do, they enjoy what they do enough to actually do it over and above what they have to for [the university]. And any student that shows you that, you instantly know, wow they might actually be picking this as something they want to do as a career.

Employers want to get an idea about the person behind the résumé. They are saying that it is important for students to get their personality across as part of the job application process. They emphasize that there is not one defined set of characteristics that make a person suitable. Different jobs and companies require different sets of skills and abilities. For successful recruitment employers need to be able to identify candidates’ skills, abilities and overall personality to be able to match applicant and position. Employers emphasized that it is essential for students to have a life outside their studies.

And we tend to look for the people who appear rounded and have got a life outside of study, and then if there is still too many to interview we tend to go for a higher grade.

Employers are looking for creativity, problem solving abilities and the capacity to learn. Students must be able to demonstrate these abilities when they are seeking jobs. They must
have the ability to take responsibility and work independently. Students must show the potential
to evolve and pick up new skills.

Current knowledge is not as important as the ability acquire new knowledge.

Employers are looking for team players. Students must be able to understand the different
roles and personalities in a team and how they fit together. Students must understand their own
natural tendencies and recognize how they can fit into a team environment. This recognition
is essential for developing one’s own strengths and weaknesses. Independent work is at times
essential but students must know when to contribute back to the team and they must know
when to ask for help.

Being able to work in a team is a critical skill and actually quite vital to success in the work place.

Employers are looking for people with good communication skills. Spoken and written com-
munication and presentation skills are all considered as highly desirable skills. Someone who
is capable of explaining something usually understands it. Employees need to be able to com-
municate and build relationships on various levels: within their team, within the company,
within the industry, across various levels of professional hierarchy.

In the past I have had occasions where the difference between someone being hired and not hired was because
he was able to present complex technical context in plain English, and that was the only reason he got the job
over the other person, who was actually technically more competent.

Employers are looking for the ability to organize oneself. It is important to show understanding
and to know which processes to apply, to be able to prioritize and coordinate multiple tasks,
to know when to keep going and when to stop.

4.2 Desired content and appearance of an ePortfolio

Portfolios should contain examples of the student’s work. There should be at least one example
for each of the areas in the skills section and these examples should come from a variety of
contexts. The ease of access to examples in an electronic portfolio is appreciated by employers.
Examples add valuable information to what is available in a curriculum vitae. The purpose of
each example and the skills the example tries to demonstrate need to be very clear. The reader
must be able to grasp this point quickly, without having to work through a large amount of
material.

The examples and the overall content of the portfolios should not be restricted to university
education or paid work. Involvement in outside activities is seen as invaluable. Such involve-
ment indicates well-roundedness and stability in a person and is absolutely important for a
good life-work balance. Participation in outside activities shows that a student can interact with
people with varied interest and abilities outside their peer group. This is especially important
for demonstrating ability in teamwork.

It’s those classic old things [e.g., sports club] that people used to hammer into me and I used to ignore, that now
as an employer I see how incredibly relevant it is.

It is essential that students reflect on their experiences. Reflecting demonstrates openness
to learning. Not everything in life goes straight or right the first time. What is important is to
recognize and analyse problems and to make decisions for the future. It can be valuable to
talk about some painful learning experiences in a portfolio.

Some of the people we have interviewed have been simply pathetic, when asking them to try and describe
good examples of teamwork and why it was a good team they worked on. ... [they are] not aware of the human
dynamics that are going on, they just haven’t grown up enough.
Portfolios should describe personal development. It is crucial to develop as a person and to be self-aware. Constructing a portfolio contributes to personal development and a resulting portfolio presentation gives the ideal tool for presenting oneself in entirety.

[Employers don’t want someone who has] spent their whole youth in front of a play station or playing war games over the internet.

Development of a portfolio is not an easy task. One has to start somewhere, ask for feedback and improve. One needs to learn from the process and has to be able to take constructive criticism on board. The personal development aided by the construction of a portfolio will be of lasting benefit.

They don’t actually think about the fact that [if] they went and asked this person and that person and that person and got them to help them and work with them they might actually come up with a more robust solution.

In terms of structuring a portfolio it is important to capture the attention of an employer very quickly. Once this is achieved the employer is willing to look in more detail. Employers want to be able to look at the portfolio and understand what it is all about at a glance. A short paragraph explaining what the portfolio is about will be helpful. A portfolio should be written from a personal perspective, using the first person in the writing. The student has to be cautious about what to take for granted, making a careful judgement on the knowledge of the potential employer about various degree structures and course content. It will make a difference to an employer if the student has chosen a subject because they had to or because they were interested. Paying close attention to detail is essential. Like in any document spelling mistakes make a bad impression. Navigating the portfolio and viewing the examples must be straightforward and has to work on the first ‘click’. It is better to use simple example representations that work in any electronic environment and offer a more complex demonstration for a face-to-face meeting.

4.3 The value of constructing and presenting an ePortfolio

Employers see portfolios as important tools for facilitating and demonstrating personal development. The effort spent on a portfolio is an investment that will bring benefits for a long time. A student who has worked on a portfolio is not only able to showcase their skills better, but as well is better prepared for an interview situation and to deal with the challenges of working in a collaborative but competitive working environment. A portfolio makes a student stand out and creates a favourable opinion, already before the start of an interview. Employers recognize and credit the effort the student has put into constructing a portfolio. A portfolio shows that the student has been proactive and organized, and has realized the value of investing effort. A portfolio makes the selection of who to invite for an interview easier and can tip the balance on a close decision.

What you need to do to distinguish yourself from the other 30 or 40 graduates you are competing with is to show me as a prospective employer real interest in your subject and that you value what you are studying. It shines like a beacon if you have passion and enthusiasm for what you do. An ePortfolio will be a vital tool for making a good impression. It will give you a head start even before you sit down for an interview because as an employer I already will have a favourable opinion of you.

5. Conclusions and future work

5.1 Validation of portfolio design

Feedback from industry on the value of portfolios to develop and demonstrate lifelong learning skills has been fully congruent with the information we found in the academic literature. The
importance of lifelong learning, the types of skills essential for lifelong learning, the value of providing evidence and reflection, and the emphasis on activities outside formal education all match closely. In terms of the design of our ePortfolio initiative it has been valuable to involve industry representatives at an early stage. This allowed us to make adjustments to the matrix design of our ePortfolio implementation and overall has given us the confidence that our approach matches industry requirements well. Additionally, we have been able to use the statements from industry in workshops and on our website to encourage students to create their own portfolios. Informal conversations have indicated personal growths in students who worked on their portfolios and positive comments these students received when showing their portfolios to potential employers.

5.2 Challenges with student participation

Our biggest challenge was to motivate students to invest time and effort into portfolios. As we have neither made portfolios compulsory nor giving marks this was not surprising. There were two reasons for our approach of voluntary participation. As a bottom-up initiative we were not in a position to modify degree regulations or to change the assessment structure of individual courses. We believe that the intellectual involvement required for developing a portfolio cannot be enforced and that students need to have freedom to set their own goals, objectives and future directions through continuous reflection.

Besides the obvious reasons of shortage of time and focusing effort on tasks producing more instant rewards we have made the following observations regarding student participation. When calling for registrations for our workshops we addressed engineering, computer science and teacher education students. The enrolments of teacher education students outnumbered the other enrolments by far. Our explanation for this is that there is a portfolio culture in the teacher education sector. Academics teaching in the area are aware and supportive of portfolios and employers often will demand to see a portfolio. The situation in engineering and science is different. Most of our colleagues are not aware of the benefits of portfolios for lifelong learning for our students and hardly any employer would explicitly ask for a portfolio. What is missing is the reinforcement of the message from academics, professional bodies and industry in general to create an environment for changing the mindset of the students.

Another observation centres on ownership, guidance and control. In setting up a portfolio programme two directions are possible. One is to go for an institutional portfolios setup with a centrally controlled e-portfolio system, institutional guidance and some form of monitoring of the portfolios produced by the students. The other direction stems from a social networking paradigm. The students have full ownership of their portfolios that reside in systems outside the control of the institution. The role of the institution is limited to providing information and guidance. When designing our initiative we have not considered these issues sufficiently. It is possible that quite a number of our students who had access to information on our project have taken on board our messages on the importance of lifelong learning and the benefits of portfolios. Yet, instead of taking on the institutionally-controlled portfolio system we have provided these students might well work with a system of their choice in a setting outside our university.

5.3 Move towards college-wide uptake

Despite the possibility that some of our students might have taking up the lifelong learning message we regard it as important to encourage wider participation in an institutional setting and see various possibilities. All our engineering and science students are required to take
a communication course, taught by academics from the English department, early in their university education. We are working with the academics involved to devote a small component of these courses to portfolios for lifelong learning. We need to strive towards the establishment of a portfolio culture within our College. This will require ongoing efforts in publicising the ePortfolio initiative, showcasing portfolios, reporting on feedback from industry, and creating opportunities for participation. It will be important to gain the active support of our academic colleagues and to get them to reinforce the message of the significance of lifelong learning attitudes and skills in their courses. As initiatives in other areas, for example e-learning for assessment, have shown, institutional support is essential for success (Buzzetto-More and Alade 2006, Freeman and McKenzie 2002, Sim et al. 2006, Warburton 2006). To take our initiative to the next level we need official endorsement through our College. This would emphasize the value of the project, help us to get support from other staff and gain trust from students who do not know us personally. On a practical level this could mean a home for the project on the official university web pages and a commitment to host ePortfolios of students beyond graduation. Students working on their portfolios will need ongoing support. As the literature and our own experience shows students need guidance and feedback. The selection of evidence and the writing of reflections are difficult tasks. A mentor is required to accompany students on this journey of personal growth. In order to sustain the ePortfolio initiative and ongoing success our College needs to provide institutional support.

References


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