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Contents

Stimulating self assessment and reflection in first year engineering using ePortfolios

Margaret Faulkner[1†] and Syed Mahfuzul Aziz[2]
Learning and Teaching Unit, University of South Australia[1]
School Electrical & Information Engineering, University of South Australia[2]

Abstract

Engineering graduates are required to demonstrate technical and generic competencies as well as continuing professional development skills throughout their career. As technical skills quickly become outdated, it is the lifelong learning skills and ongoing professional developments that enable graduates to adapt to changes in professional practices during their career. There is increasing agreement that the development and provision of evidence of such skills must begin at the university. Development within a program requires the alignment of learning activities and assessment tasks with graduate attributes and professional competencies. Equally important are the students' self awareness about the progressive development of competencies and their ability to document them.

The University of South Australia (UniSA) introduced a common first year of study for all its engineering programs in 2008. As part of an overall strategy to enhance student engagement and learning, ePortfolios were introduced in 2009 to stimulate student self-assessment, reflection and to provide evidence of development. Students have used ePortfolios in three core courses in the first year in a variety of ways.

This paper presents the approach taken to introduce ePortfolios across the first year engineering program as well as the lessons learnt. Students' overall perception on using ePortfolios has been captured using systematic surveys during 2009 and 2010. Analysis of this feedback along with staff experience and reflections on the issues highlight areas that are important to consider in the use of ePortfolios within an engineering program.

Introduction

Engineering undergraduate programs prepare learners for the transition from student to professional practice, working closely with the profession to develop knowledge and competencies. In recent years, the importance of going beyond developing technical skills and knowledge has been acknowledged in the literature and incorporated into practice. The IEEE model for electrical engineers published in the late 70s is said to have signalled a focus on transferable skills, with reflective skills and learning skills both viewed as essential for engineers (Carroll, Markauskaite & Calvo 2007). Engineering education needs to deliver more than acquisition of facts, with ethics, creativity and social responsibility identified as key qualities for sustainable engineering practice (Fenner et al. 2005). Interviews with UK engineering professionals confirm the growing complexity in the role of engineering with technical, personal and business skills important for roles as a specialist, integrator and change agent (Spinks, Silburn & Birchall 2007). This broader focus of the curriculum is also taken at the University of South Australia (UniSA) by embedding seven Graduate Qualities (GQs) within programs (University of South Australia):

1. operates effectively with and upon a body of knowledge of sufficient depth to begin professional practice
2. is prepared for life-long learning in pursuit of personal development and excellence in professional practice
3. is an effective problem solver, capable of applying logical, critical, and creative thinking to a range of problems
4. can work both autonomously and collaboratively as a professional
5. is committed to ethical action and social responsibility as a professional and citizen
6. communicates effectively in professional practice and as a member of the community
7. demonstrates international perspectives as a professional and as a citizen.

The development of GQs is a core element of the UniSA Teaching & Learning Framework (Hicks & Lee 2008). Curriculum design at UniSA establishes appropriate objectives and learning outcomes for the level of study, with GQs explicitly linked to enable articulation in context relevant terms, as per constructive alignment (Biggs & Tang 2007). This approach provides a quality learning environment, in terms of curriculum design. Assessments within each course verify the level of GQ development achieved by individual learners at a point in time.

However, the explicit connection between university experiences and the qualities required for professional success may not be evident to all graduates (or staff) limiting the ability to articulate the qualities developed.

Embedding self-assessment and reflection into the curriculum

The process of using constructive alignment (Biggs & Tang 2007) to design the curriculum engages staff to reflect upon the optimal learning environment to develop intended learning outcomes (Sweet 2010). However, it has also been criticised for taking a generalised approach that disregards the affective and social dimensions in achieving the intended transformations (Ellsworth 1989 cited in Meyer & Land 2005). As both dimensions are critical to developing reflective and self-assessment skills, a holistic perspective is required in curriculum design and delivery.

This links with another concern of poor pedagogical practices associated with reflection in higher education, when an instrumental approach to developing reflective skills is taken it is antithesis to the character of reflection (Boud 2010). In some professions, this criticism extends beyond graduation, with strong emphasis on monitoring staff through their reflective practice to record thoughts as well as actions (Hargreaves 2010).

Despite these concerns, the use of evidence to accredit professional competence is expected to increase (Zukas et al. 2010).

It is timely to review the challenges faced by program teams and to identify insights gained from experiences useful for supporting higher education in the 21st century. The first year engineering program at UniSA is provided as a case study on an approach taken to embed ePortfolios within the curriculum to increase the opportunity for self-assessment and reflection.

Research Questions and Methodology

This paper aims to address the following research questions:

- Whether and how ePortfolios can support student self assessment and reflection?

- How do the students perceive and embrace the use of e-portfolios?
- What key factors impact upon the use of ePortfolios as a reflective and competency documentation tool?

Whether and how ePortfolios can support student self assessment and reflection

ePortfolio concepts and tools offer a long-term perspective of learning with value that extends beyond graduation and into professional practice (Joint Information Systems Committee (JISC) 2008; Hallam & Creagh 2010).

An audit of the use of ePortfolios in higher education concluded that there was an even balance of formative and summative assessment that focused on the final product, the elements included as evidence and reflections on the process of developing an ePortfolios (Hallam et al. 2008). Underlying the effective use of ePortfolios are self-assessment and reflective skills, required to capture relevant evidence and to present this in a meaningful format for multiple audiences. This led to UniSA's first year engineering program exploring the value offered within that context.

As part of a university-wide pilot study initiated in 2009 using the *PebblePad* tool (www.pebblepad.co.uk) ePortfolios were introduced in first year engineering. The *PebblePad* system supports more than the creation of ePortfolios (termed webfolio in the system), with blogs, action plans, development profiles and cohort reporting also enabling process and presentation aspects associated with ePortfolio use (Pebble Learning). As the system provides a wide variety of ways to support self assessment and reflection, it was important for the first year academic director and course coordinators to explore approaches appropriate to their learning context.

First year engineering students were initially introduced to the concepts of ePortfolios during an active orientation program (Duff et al. 2009). The program was designed to assist students to transition smoothly into university studies by forming connections with peers through the creation of an ePortfolio that captured their orientation experience. The use of an ePortfolio was optional with support provided by a mentor and a small prize offered as an incentive to engage with the process.

This was followed with students using ePortfolios in two courses in the first half of the year, and one course in the second half. A snapshot of the tasks students performed using the ePortfolios are given in Table 1 followed by a brief overview of the approach taken.

Table 1: Assessment tasks using e-portfolios in first year engineering

Course name	e-portfolio tasks	Weighting
Sustainable Engineering Practice (SEP)	Self awareness exercises; reflections on the course, industry interactions and individual contributions to group project (total ~2000 words)	45%
Computer Techniques (CT)	Presentation of engineering drawings & 3D models, reflections, and self assessment of graduate qualities	50%
Engineering Design and Innovation (EDI)	Ongoing work diary to keep on track with group project (~500 words); reflections on individual contributions to the project and learning throughout the course	25%

Computer Techniques

The first year Computer Techniques course concentrated on developing self-assessment skills during a six week Computer Aided Design (CAD) activity (Fielke & Quinn 2009). A webfolio was created to capture learning during the six weeks in a multi-media format. It provided a place to consolidate and reflect on work generated from course activities and included engineering drawings, 3D models, photo rendered images and animations from another computer program called *SolidWorks*.

Learners were provided with an online profile of the professional competencies developed during the course and this was used to self-assess their level of competency at the beginning and end of the course. Learners were asked to self-evaluate their work submitted for summative assessment by indicating their expected grades.

Sustainable Engineering Practice

The first year Sustainable Engineering Practice (SEP) course typically has an enrolment of around 200 students (Smith 2010) and provides an environment that develops critical reflective skills by engaging with the concept of sustainability. Learners create a webfolio to capture their reflections of industry interactions, course content and self-awareness exercises and evaluation of their role in a group project (Smith & Mills 2009).

A template is provided where the coordinator provides a model webfolio. This guides learners and helps to focus on the reflective elements. This includes a blog for formative feedback that details reflections from participation in the group project. The course coordinator emphasises the use of the blog for personal, rather than group, reflection and aims to establish conditions so that learners do not fear negative consequences from sharing thoughts on the course experience (Smith 2010).

Engineering Design and Innovation

The lecturer for SEP also coordinates the course in the second half of the year that embeds ePortfolios, Engineering Design and Innovation (EDI). The course supports learners to recognise the roles of systems thinking, innovation and creativity in the design process. It features four assessment tasks, including development of reflective skills through an ongoing individual work diary. Self-assessment and reflective skills are also demonstrated early in the course through a short report accompanying the first group project (Smith 2010).

In 2009, students in EDI were given the choice of how they submitted a work diary for assessment. A survey in the beginning of the course indicated a preference to continue using *PebblePad*, with the majority indicating submission via this system rather than external tools to create a blog, wiki, or a word document (Fielke & Quinn 2009; Smith 2010).

Staff perspective of the value of ePortfolios

In 2010, the program decided to continue with the use of *PebblePad* to support learners in developing self assessment and reflective skills. Experiences in 2009 confirmed the potential of ePortfolios within each context chosen, but also identified the need to overcome challenges in order to achieve this. Changes were introduced in 2010 to improve the student and staff experience. This included refinements to resources, such as step-by step-instructions on the use of *PebblePad* and its various features and the templates for student ePortfolios in courses so that students were clear on expectations and spent less time formatting and more time on reflection.

Evidence of developing reflection skills

In orientation, *PebblePad* is used to support reflection through the journaling of the orientation activities (Duff et al. 2009). An anonymous online evaluation survey indicated that less than half of students in 2009 (46%) created a *PebblePad* account as part of orientation (Fielke & Quinn 2009). The submissions varied in terms of the experiences shared and the approach taken by groups. There were examples of groups connecting with each other and the university environment, with multi-media elements in their presentations including links to other sites (e.g. past school) and loading of photos (e.g. self, campus).

The activity was considered a useful component of orientation and was replicated in 2010, with organisers noticing an improvement in the engagement by mentors and learners with an increase in the number of ePortfolios submitted. Unlike 2009, staff and mentors supporting first years in 2010 benefited from prior experience. This familiarity facilitated a greater focus on supporting learning and less on grappling with technology.

From the use of ePortfolios for the SEP and EDI courses in 2009 a number of areas were identified that impacted the ability of staff to support development of reflection skills (Smith 2010):

- The inexperience of staff with using *PebblePad* in 2009 impacted their ability to deliver formative feedback to support development of reflection skills.
- The freedom given to learners in selecting the format used to share reflections needs to be balanced against the additional time taken for staff to provide feedback.
- The weighting given to assessments needs to be matched against workloads of both staff and learners.

Evidence of developing self-assessment skills

The ability of learners to self-assess was examined in the Computer Techniques course by comparing anticipated grades of learners against their assessed grade (Fielke & Quinn 2009). The results showed the Dunning-Kruger effect (Dunning et al. 2003), with 65% of first year learners predicting within one grade of their assessed grade, 15% over-predicting and 25% under-predicting their grade. A linear relationship was also found between participation in the self-assessment activity and the grade achieved (Fielke & Quinn 2009). Hence, the use of ePortfolios enabled not only supported learner development in this area but also provided valuable insights for teaching staff to incorporate into future iterations of this course. Recommendations were made to not only continue supporting learners in this course but for the extension of support to other areas of the curriculum and the continuing professional development of engineers (Fielke & Quinn 2009).

How do the students perceive and embrace the use of e-portfolios

Student feedback on the use of *PebblePad* to support reflection and self-assessment has been obtained in a number of ways. The earliest indication provided to the program is from evaluation of its use in the orientation activity. In 2010, an anonymous online survey to students included a free text field to capture the most useful aspects of orientation. A small number (4) mentioned the creation of the webfolio (76 of approximately 230 enrolled in first year engineering responded to the anonymous survey). However, there were also a couple that mentioned the need for further support due to difficulties with using *PebblePad* for the activity.

In addition to the insights obtained by course coordinators specific to their learning environments, students were invited to provide their overall evaluation on the value of using ePortfolios to support their learning. A survey instrument designed in collaboration with RMIT

university (Faulkner & Allan 2009) was administered to the first year engineering students in 2009 and 2010. The instrument consisted of a number of statements where students were asked to use a 5-point Likert scale to indicate their level of agreement. It also captured their overall views in an open ended text field along with demographic and usage items.

In 2009, 139 responses from a total population of 199 (70% response rate from in-class session enrolment) were analysed from anonymous hard copy surveys completed in June. This research was approved by the UniSA ethics committee and students were provided with an information sheet explaining the purpose of the research prior to distribution of surveys at teaching sessions. Completed surveys were scanned by RMIT university with an excel spreadsheet used to analyse responses.

In 2010, permission was granted to extend the evaluation research into 2010 and to alter the methodology to enable data collection via an anonymous online survey instrument. This replicated most 2009 items and included two additional statements relating to the development of reflective skills. The response rate in 2010 was much lower with 75 responses from a population of 230 (33% response rate). The change from in-class to online survey is noted to reduce response rates (Dommeyer et al. 2004) and has limited the ability to comparatively analyse and interpret data.

Table 2 indicates the total number of responses each year and lists the number that either agreed or disagreed, to show if the views of students are polarised. Neutral responses are not reported. The percentages for each item exclude any 'not applicable' responses.

The level of agreement has increased for all statements (except for NOT using ePortfolios unless required for assessment) in 2010 from 2009. This has corresponded with a decrease in disagreement, suggesting changes that were introduced have improved the student experience.

Despite means of 3 or higher for all but one statement in 2010, there remains a substantial group of first year students who do not value the experience of using ePortfolios. A similar mix of love/hate responses was found in other UniSA disciplinary areas (Waye & Faulkner forthcoming).

Table 2: Student agreement or disagreement with statements in first year engineering courses

Statement	Agreement		Disagreement	
	2010 % n = 75	2009 % n = 139	2010 % n = 75	2009 % n = 139
*I understand the benefits of self reflection**	76		4	
The role of my ePortfolio has been clearly communicated to me	71	41	14	23
I have received enough support and direction on the construction of my ePortfolio in my course	64	38	25	27
My ePortfolio was easy to create	62	39	22	35
I would NOT use ePortfolios unless required as part of assessment	**59**	**72**	**13**	**15**
My ePortfolio demonstrates development of my understanding and learning	59	33	18	30
I have been provided with constructive feedback on my ePortfolio	56	38	19	29
My ePortfolio has increased my skills of reflection	55	25	20	43
My ePortfolio allows me to display my competence as a graduate to future	50	26	22	36
My ePortfolio enabled me to formulate a personal development plan	46	27	22	43
My ePortfolio assists me in identifying areas in my learning that require further attention	44	26	26	42
I found the ePortfolio User Guides useful	41	25	27	35
I am reflecting on my learning outside of PebblePad*	38		14	
In my future career, my e-portfolio is a tool I may use to document my professional development	38	21	31	47
Creating my ePortfolio increased my information literacy skills	38	20	29	49
I have used my ePortfolio to document my learning experiences and achievements in other areas than those directly related to assessment in my course	36	26	36	51

Table 3 lists statements rated on a 5 point Likert scale, reporting means and standard deviations in 2010 and 2009. * denotes items introduced in 2010.

The importance of embedding ePortfolios and mandating their use is reinforced, with the high levels of agreement for the statement '*I would NOT use ePortfolios unless required as part of assessment'*. The statement '*I have used my ePortfolio to document my learning experiences and achievements in other areas than those directly related to assessment in my course'* had the lowest level of agreement in 2010 and indicates that the lifelong and life wide potential of using ePortfolios is not understood by first year engineers. A more positive finding is that the benefits of self-reflection were well understood with the highest mean (3.9) and lowest standard deviation (0.7). Table 3 illustrates the wide variation in responses from respondents, with polarised views on the benefits of ePortfolios.

Table 3: Student ratings of ePortfolios in first year engineering courses

Statement	Mean 2010	Std Dev 2010	Mean 2009	Std Dev 2009
*I understand the benefits of self reflection**	3.9	0.7		
The role of my ePortfolio has been clearly communicated to me	3.7	1.0	3.2	1.0
I have received enough support and direction on the construction of my ePortfolio in my course	3.5	1.1	3.1	1.0
My ePortfolio was easy to create	3.5	1.2	3.0	1.2
I would NOT use ePortfolios unless required as part of assessment	3.8	1.0	4.0	1.2
My ePortfolio demonstrates development of my understanding and learning	3.4	0.9	3.0	1.0
I have been provided with constructive feedback on my ePortfolio	3.4	0.9	3.1	1.0
My ePortfolio has increased my skills of reflection	3.4	1.0	2.8	1.1
My ePortfolio allows me to display my competence as a graduate to future	3.3	1.0	2.8	1.1
My ePortfolio enabled me to formulate a personal development plan	3.2	0.9	2.7	1.1
My ePortfolio assists me in identifying areas in my learning that require further attention	3.2	0.9	2.7	1.1
I found the ePortfolio User Guides useful	3.1	1.1	2.8	1.1
I am reflecting on my learning outside of *PebblePad**	3.3	0.8		
In my future career, my e-portfolio is a tool I may use to document my professional development	3.0	1.1	2.5	1.1
Creating my ePortfolio increased my information literacy skills	3.0	1.1	2.6	1.1
I have used my ePortfolio to document my learning experiences and achievements in other areas than those directly related to assessment in my course	2.9	1.1	2.6	1.2

Comments were collected in the survey to better understand the student experience. Both negative and positive comments were reported. Positive responses included:

- *Easy to use, good tools, would recommend it.* (2010)
- *ePortfolios is a great help for students in UniSA. It has many benefits as we are able to communicate with the teachers throughout the year in* PebblePad. (2010)
- *Once understood, easy to use and helpful.* (2009)

Negative comments can be broadly classified as concerns with either the technology or pedagogy. Staff have noted that some students struggle with reflective assignments whether submitted using an online portfolio or in other formats (Smith 2010). The range of responses to statements and types of comments illustrated diversity across a first year program in how learners value approaches to developing self-assessment and reflection skills.

These skills have not traditionally been associated with engineering practice (Meyer & Land 2005), so showing relevance to professional practice is vital for student engagement. This is illustrated by the following comment:

- *I found it to be frustrating and the* PebblePad *software was anything but intuitive. I really don't see how writing a blog will make me an engineer. Since I'm already working in the field, I can see just how little real engineers use such software. I'd rather just get into the work rather than reflecting on how a* SolidWorks *drawing made me feel. This is the second subject in which I've been forced to use* PebblePad*, and I've found the experience to be tedious. I really hope that I never have to touch that horrible software again, but I know that's not the case.*

Survey results also confirm that usability and perceptions of the fit for purpose of the ePortfolio system are important for engagement. *PebblePad's* design has not been well received by all engineering students, with its interface likened to a tool found in primary schools rather than universities (Smith 2010).

In 2009, technical difficulties associated with the introduction of *PebblePad* and integration with other UniSA systems were compounded by the large number of files students embedded in the Computer Techniques course. This slowed the system when many students attempted to upload files close to the deadline. The initial design anticipated most learners submitting continuously during the course to avoid this issue and to provide an opportunity for formative feedback. The experience suggests that first year students may not realise the benefit of this approach, this may be due to not yet experiencing the value of formative feedback in this environment.

Unfortunately, for many students in 2009 the submission process via *PebblePad* appeared to make an already stressful situation very frustrating. These negative experiences led to the optional use of *PebblePad* in the second half of the year. Despite the troublesome nature of its use, the majority of students indicated they would continue with its use for assessment submission of the work diaries in the next course (Fielke & Quinn 2009; Smith 2010).

The results indicate that first year students have begun to perceive ePortfolios as a useful way to display competence as a graduate in the future. This aspect is also noted in comments made at the end of the survey:

- *They are useful tool of documenting one's journey from student to professional.* (2009)
- *ePortfolios are very useful for the engineers in their own fields. It helps me to create my resume and understand about the career episode reports and present my research studies.* (2010)

Many respondents in 2010 (55%) agreed that the use of ePortfolios in the course had increased their reflective skills, this was an improvement from 2009 when 25% agreed (note: 43% disagreed in 2009 compared to 20% in 2010).

- *Good for Personal Reflection for whatever we are doing and helping us build a foundation for the future.* (2010)

Research suggests ePortfolios follow the typical S-curve for adoption of technology (Reese & Levy 2009). Hence, time is needed for embedding ePortfolios across a program and in adjusting pedagogical practices. The results of this research support the changes introduced following evaluation in 2009 to improve the experience for staff and students (Fielke & Quinn 2009; Smith 2010). It is anticipated that the perceived value of ePortfolios will also increase as learners progress in their program and have more opportunities to capture evidence in ePortfolios that are used for more than assessment purposes. Ideally, it will be perceived as a useful tool for supporting the transition from learner to engineer.

What key factors impact upon the use of ePortfolios as a reflective and competency documentation tool

A number of factors important to ePortfolio implementation have been identified in the literature previously (Hallam et al. 2008; Joint Information Systems Committee (JISC) 2008; Faulkner & Allan 2009; Joyes, Gray & Hartnell-Young 2010) and were confirmed by our experiences. The factors we identified as relevant to success across a program are:

Identify connections across the program and beyond

Although an ePortfolio approach is possible within a specific course, this is unlikely to provide a holistic perspective on how learners are prepared for professional practice. It also reduces the potential benefit from engagement with ePortfolios as the investment required in learning new technologies or approaches is of limited value. To realise the potential of ePortfolios for learning requires a lifelong learning approach, i.e. not only used for preparing for graduation but beyond this timeframe. This may require a review of the curriculum to not only provide feedback on achievements but to support the continued development of learners upon graduation (Boud & Falchikov 2006).

Demonstrate relevance to professional practice

Results of our research indicate that not all first year engineering students prefer an ePortfolio approach. This may change as they progress through the curriculum (Smith 2010) and experience the value of the approach in multiple courses across the program.

It is important that learners do not perceive their experience as an assessment hurdle, with ePortfolios providing an authentic place for learning. One of the ways to do this is by showing relevance to the development of skills and abilities required in the profession. Career Episode Reports used to attain chartered status following graduation is an example of how relevance is currently shown.

Build capacity across the program team

The support of multiple staff is important to not only show relevance of the approach across the program but to ensure it is sustainable if staff leave or have other commitments. The apparently slow approach of commencing with three of eight first year engineering courses has enabled refinement within these courses and built confidence in embedding ePortfolios across the program team. Time is required to explore the specific challenges of implementing ePortfolios within their context in order to identify strategies to support their effective use.

In addition to overcoming technical difficulties, the social and affective dimensions are important factors that require matching teaching approaches with the philosophy underlying ePortfolios (Barrett & Wilkerson 2004). It is not expected that all courses and staff will benefit from ePortfolio approaches, but it is important for learners to engage with the concepts introduced in first year in other year levels. A 2nd and 3rd year course in engineering have already begun to introduce ePortfolios and over time further courses and staff are expected to engage with the concepts.

The transition to higher education has been the initial focus in the program, with an ePortfolio capturing connections with peers across different year levels and staff that can support their learning (Duff et al. 2009). This could expand to include practitioners and professional associations as learners' progress towards becoming engineers.

Conclusion

This paper has provided an overview of the approach taken in a first year engineering program, where the purpose of embedding ePortfolios is to support the development of self-assessment and reflective skills to aid the process and provision of evidence of becoming an engineering professional. The use of ePortfolios has been explored as a way to support curriculum changes to shift the focus 'from assessment of learning to assessment for learning' (AeP 2008 p.17).

Support is shown for the potential of ePortfolios, but there are many challenges yet to overcome before all year levels are supported in using ePortfolios to develop GQs and present a rich picture of their competence to employers and the profession. A number of factors have been outlined that highlight the long-term perspective required of any program or institution looking to implement ePortfolios. This requires support from the program team and support areas within the institution and professional area to be successful.

UniSA is establishing conditions that will support ePortfolio approaches. The *Mahara* ePortfolio tool is being implemented at UniSA in 2011 and will be integrated with *Moodle*. The program team will continue to evaluate the perceptions of learners and staff on the value of ePortfolios. Work is also continuing to strengthen the connection between the program and profession to offer benefits beyond graduation.

Whilst the program has benefited from evaluation surveys in the past two years, we acknowledge its limitations in generalising beyond first year as cross-sectional designs cannot show development of learners. This is an important area for further research that requires resources for longitudinal research beyond those available to a program team.

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† Corresponding author: Margaret.Faulkner@unisa.edu.au