

The learning outcomes of an online reflective journal in engineering

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Reflective thinking based on experiential learning is a key skill required for the lifelong learner and the socially mature professional. Following several semesters employing a written reflective journal as an assessable task, a fourth-year engineering management unit adopted an online reflective journal. During the initial semester of use, an evaluation was undertaken to investigate student perceptions of the online journal. A summary of this previous work is presented here. Following three semesters of use of the online journal, an analysis of the student use of the journal was undertaken to investigate its contribution to unit learning outcomes. Based on the evaluation of student perceptions of the online reflective journal, it was found that a majority of students understood the purpose of the journal, and valued the journal in their learning; a majority of students read the journal entries of other students, and indicated that this assisted their learning; and the two most frequently reported 'most useful' aspects of the journal were the 'enforced' continuous revision of course material, and the ability to compare their understanding of the course material with that of other students. Based on a regression analysis of the factors related to student usage of the online reflective journal, it was found that the significant contributors to final unit mark were: prior academic performance; number of journal postings; and mode of study. This research confirmed that the online reflective journal was fertile territory in the landscape of educational technology, both in terms of student perceptions and contribution to unit learning outcomes.

Keywords: reflective journal, engineering management, online journal, student evaluation, learning outcomes.

Introduction

Students in a fourth-year engineering management study unit were asked to complete an assessed reflective journal as an exercise in developing professional journaling skills and as a reflective writing and critical thinking activity. Following a number of semesters of use of a hardcopy reflective journal, the format of this assessment task was moved to completion online. To measure student perceptions of this new mode of assessment, a formal evaluation was undertaken. Following the generally positive student evaluation of the perceived value of the online reflective journal on its introduction, it was retained as an assessable item in the unit for following semester offerings. A range of student demographic and reflective journal usage data were collected over three successive semesters of offer of SEB421. This paper explores the value of reflective journaling in engineering education, presents a case study of the introduction of an online reflective journal, presents the results of the students' initial perceptions of the online reflective journal, and investigates the contribution of the online reflective journal to unit learning outcomes, contrasting the latter quantitative results with the former student perceptions about the value of the online reflective journal.

Reflection and reflective journals

In the context of learning, reflection refers to the active intellectual monitoring and evaluation of one's own formal learning and professional practice activities, to examine them for new understandings that add to the individual's accumulated knowledge and experience. Reflective thinking based on experiential learning is a key skill required for the lifelong learner and the socially mature professional (Kolb, 1984; Schön, 1995). As members of one of the design professions, many engineers regularly encounter new and unique problem situations, and the process of designing solutions for these problems provides a fertile ground for experiential learning and reflection on action. Effective use of reflection is an important element of the on-going professional development of engineers. The use of a reflective learning journal

(due to the requirement to transfer thought processes into words) is thought to be a valuable tool in developing self- and critical reflection in students (Chirema, 2007; Cottrell, 2006; Jolly, Radcliffe & McLeod-Palma, 1999; Pavlovich, 2007). For the practicing professional, the use of a work journal offers additional benefits – it may be an admissible legal document in the case of a dispute about the conduct of work, and it may be a valuable record of the completion of project work (Scott & Assadi, 1999). The use of a reflective journal in the undergraduate preparation of engineering students is an opportunity to develop a familiarity with work journals and reflective practice.

There is evidence of the value of reflective journals for professional development and enhanced learning outcomes, in engineering education contexts, in the literature (Armarego, 2007; Broadway, Qammar, Evans & Spickard-Prettyman, 2005; Mitchell & Delaney, 2004). In a composite materials class a reflective journal was used for students to describe a real application of a section of theory presented in class. It was suggested that, “These [journals] give the students the opportunity to make use of the theoretical knowledge they meet in each section of the course by reflecting on how it is applicable to a real application. The goal is for better, more integrated understanding...” (Lundström & Booth, 2002). In another trial of reflective journal writing, it was found that, “...when students voluntarily write reflective journal entry essays on assigned reading, their performance on multiple-choice quizzes on the reading is improved compared to students who did not complete such essays.” (Burrows, McNeill, Hubele & Bellamy, 2001)

It is recognised that reflection is not only an individual activity, but may contain social/learner-learner aspects as well (Kemmis, 1985; Verdonshot, 2006). It is reported that collaborative reflective activity and the ability to compare one’s own thinking with that of other learners yields positive results and better facilitated learning than individual reflection (Kim & Lee, 2002). It was identified in the composite materials class case above that an important future enhancement of the use of reflective journals would be the incorporation of a social dimension to allow individual students to contribute to the development of a collective understanding (Lundström & Booth, 2002). The development of computer conferencing and computer managed communication (CMC) systems, and more recently, social software tools such as blogs and wikis have provided a wide array of online communication and collaboration tools that can be used for online journaling, including reflective journaling (Bennett & Pye, 2002; Boulous, Maramba & Wheeler, 2006; Xie, Ke & Sharma, 2008).

An online reflective journal in engineering education

At the time of the case study documented here, the School of Engineering and Technology (now the School of Engineering and Information Technology) at Deakin University in Australia offered a three year Bachelor of Technology (BTech) and a four year Bachelor of Engineering (BE) at undergraduate level. The programs were delivered on-campus, off-campus and off-shore in Singapore and Malaysia (through twinning partner institutions). The first author had academic responsibility for the fourth-year engineering management study unit SEB421 Strategic Issues in Engineering. This unit consisted of three modules:

1. Technological Forecasting and Assessment;
2. Policy Design in Engineering Organisations; and
3. Issues in Productivity Improvement.

The Technological Forecasting and Assessment module discussed methods for long-term forecasting, factors in technological innovations, and the impact of technological changes on business and society. The topics in the Policy Design in Engineering Organisations module were policy structure, designing organisational structure to support policy, and modelling and analysis of policy alternatives. The Issues in Productivity Improvement module focused on labour and management productivity, productivity improvement techniques, benchmarking and the changing nature of work practices. The first author had previously employed a paper-based individual reflective journal as an assessment activity in this study unit (Palmer, 2000).

Prior to the introduction of the online journal, each student was required to keep an individual hardcopy reflective journal. The purpose and value of reflection as one of the main avenues for the self-development and consolidation of knowledge based on the experience of the practicing professional was explained to the students. At the completion of the weekly class, students were asked to respond in writing in their journal to the following two questions, “What did I learn today?”, and, “How will this be of use to me in the future?” As long as the response was thoughtful and considered, students received one percent of their final grade for each week that they completed a journal entry, up to a maximum of 10

percent. This class also contained off-campus students who completed their journal across the semester at their home location, and submitted their completed written journal at the end of the semester. The hardcopy journaling process had a number of limitations. A significant amount of on-campus class time was taken up by the reflective journaling and marking on-the-spot processes. Off-campus students were required to submit their completed reflective journal at the end of the semester for marking – it was clear that some journals had been hastily compiled just prior to the due date, rather than having been a vehicle for student reflection across the duration of the semester. Finally, the individual hardcopy reflective journal was primarily a solitary enterprise with no social reflection component. The move to a weekly online reflective journaling assignment task was not proposed or expected to be somehow ‘superior’ to the previous hardcopy journaling process, rather it was viewed as an alternative process that offered potential solutions to the previously observed limitations of the hardcopy journaling process.

At the time of the case study documented here, Deakin University used the WebCT Vista (now Blackboard Vista) online course management system (CMS). Using the CMS to move to an online format reflective journal, students in SEB421 were asked to make their weekly journal entry in an online discussion area. The discussion area was essentially an asynchronous bulletin board to which all class members had read and write access. A separate discussion sub-area was created for each nominal class week to provide some structure and direction to students, and to break the large number of student postings into manageable sections. The same assignment questions and marking criteria as previously used for the hardcopy journal were retained for the online journal. While it is recognised that criterion referenced marking of student reflective journals may potentially constrain student expression, at the same time, it can encourage greater student engagement with the intended pedagogical aims of the journal (Pavlovich, 2007). Ultimately, what is assessed sends strong messages to students about what is valued, and the allocation of marks to an assessable piece of work is a strategic tool for creating student engagement (James, McInnis & Devlin, 2002).

In addition to on-campus and off-campus Australian students, the class also contained a significant proportion (approximately 30 percent of the enrolment) of students studying in Malaysia and Singapore. The online nature of the system meant that all students could post their journal entries weekly, regardless of their study location or mode of study. Because the journal entries were posted to a discussion area with open read access to all class members, all journal postings were potentially available to all students to read. While there was no formal requirement for students to read and/or respond to the journal entries of other students, in recognition of the potential enhancement of reflection arising from the social aspects of reflection, students were encouraged to view the journal postings of their class peers. In addition to the formally assessed weekly journal discussion areas, there was a single general SEB421 discussion area open for students to make general postings and to ask questions on any topic.

Previous investigation

To assess student perceptions of this new development in the application of an online reflective journal, a formal evaluation in the form of a written questionnaire was undertaken. At the end of the semester the questionnaire was distributed to on-campus students in class, and was mailed to all enrolled off-campus students. Off-campus students were provided with a ‘reply-paid’ envelope, so their completed questionnaire could be returned at no cost to the student. As required by the Deakin University Human Research Ethics Committee, participation in the survey was anonymous and voluntary. The questionnaire sought responses under the following categories:

- demographic information – age; gender; course of study; location of study;
- reflective journal – did you understand its purpose?; rate its value;
- use of journal – frequency of access; did you read submissions of other students?;
- online system – rate the system’s ease of use;
- general – what aspects of the online reflective journal were most useful?; least useful?

The full details of the evaluation are reported elsewhere (Palmer, 2004), but, the following presents a summary of the results. Table 1 provides the response rate and demographic information for the overall enrolled student population and survey respondents at the end of the semester.

The gender, course of study and study location characteristics of the entire class group were known, permitting a comparison of the population and respondent sample groups. No significant differences between the respondent sample and the total enrolled population were observed in any of the demographic characteristics tested. This, combined with the reasonable response rate, suggests that valid

Table 1: Response rate and demographic information

Number of valid responses	Total class enrolment	Response rate
43	83	51.8 percent

Mean age	Standard deviation	Age range	Median age
26.1 years	7.7 years	19 to 47 years	22 years

Characteristic	Respondent sample %	Class population %	Chi-square test
Female	9.3	8.4	$\chi^2_1 = 0.027, p > 0.869$
Male	90.7	91.6	
Engineering	88.4	95.2	$\chi^2_2 = 2.079, p > 0.353$
Technology	7.0	2.4	
Other†	4.6	2.4	
On-campus	55.8	41.0	$\chi^2_3 = 4.555, p > 0.207$
Off-campus (Australia)	30.2	28.9	
Off-campus (Singapore)	0.0	1.2	
Off-campus (Malaysia)	14.0	28.9	

† - International exchange students and non-engineering students enrolled in a single unit only.

conclusions about the population group can be inferred from the respondent group. Table 2 provides a summary of the questionnaires responses relating to value and use of the online reflective journal.

Table 2: Responses relating to value and use of the online reflective journal

Question	Response	
Clearly understood the purpose of the reflective journal?	Yes = 92.9 percent	No = 7.1 percent
Value of the reflective journal in their learning (1=low;5=hi)?	Mean = 3.6	Std Dev. = 0.87
Frequency of accessing the reflective journal?	Daily	2.3 percent
	2-6 per week	14.0 percent
	Weekly	51.2 percent
	Less than weekly	32.6 percent
Read the reflective journal entries of other students?	Yes = 97.7 percent	No = 2.3 percent
If yes, did reading entries of others assist your learning?	Yes = 76.2 percent	No = 23.8 percent
Ease of use of the online journaling system (1=low;5=hi)?	Mean = 3.8	Std Dev. = 1.12
Value of the general SEB421 discussion area (1=low;5=hi)?	Mean = 3.2	Std Dev. = 0.85

These results suggest that:

- additional explanation of the purpose of the reflective journal would be of benefit to a small percentage of the students in this unit;
- the reflective journal was considered valuable by a majority of students in the unit;
- a majority of students did not access the online journal more than weekly. This outcome is likely to be related to the unit assessment requirement for journal entries to nominally be made on a weekly basis;
- a majority of students derived some benefit from reading the journal entries of other students;
- the Vista CMS was generally considered easy to use for the task of completing online journal entries; and
- the perceived value of the general SEB421 discussion area was lower than the online reflective journal. This may be related to the fact that completion of the online journal was an assessable task, and hence given a higher priority by students, while participation in the general discussion area was at the discretion of the student.

Those respondents who indicated that reading the journal submissions of other students assisted their learning gave a significantly higher rating to the value of the reflective journal in their learning, and also a significantly higher rating to the value of the general SEB421 discussion area. These two observed correlations suggest that students who found value in one online element of the unit (the reflective journal) may have been positively predisposed to other online elements of the unit.

Respondents were given the opportunity to give an open-ended written response to the question, ‘What aspects of the online reflective journal did you find most useful?’ Table 3 provides the categorised responses to this question and the frequency with which they were reported.

Table 3: Most useful aspect of online reflective journal

Most useful aspect of online reflective journal	Frequency of reporting
Continuous revision of study materials	16
Ability to compare my own thoughts with others	8
Electronic submission of entries was convenient	6
Chance to critically evaluate the study materials	4
Weekly entries helped to pace my study	1

The most frequent response related to the compulsion to review the course material for the purpose of responding to the weekly journal question, “What did I learn today?” This indicates that many students found it valuable to engage in reflection on their studies, but this does not necessarily mean that they actively engaged in critical reflection on their learning, which was an important intention of the reflective journal, and which was mentioned explicitly in responses by only four students. It is noted that the second most frequent response related to the ability of students to compare their own reflective thinking with that of other students. This was an encouraging response, as the use of a public online discussion area was purposefully employed in response to reports that collaborative reflective activity and the ability to compare ones own thinking with that of other learners can yield positive results and better facilitated learning than individual reflection (Kim & Lee, 2002).

Respondents were given the opportunity to give an open-ended written response to the question, ‘What aspects of the online reflective journal did you find least useful?’ Table 4 provides the categorised responses to this question and the frequency with which they were reported.

Table 4: Least useful aspect of online reflective journal

Least useful aspect of online reflective journal	Frequency of reporting
CMS user interface difficult to use	7
Problems with CMS operation	2
Having to think critically	1
CMS operation slow	1
No immediate feedback on weekly entries	1

The most frequent responses related not to the actual journaling activity, but rather to problems associated with the use of the CMS for the completion/submission of journal entries. This suggests that if students perceive the CMS user interface to be deficient, this will reflect negatively on their experience of the underlying educational activity that is mediated by the CMS. The critical affect of the user interface on the user’s perception of computer-based systems, irrespective of the actual purpose of the system, is documented in the literature (Chiu, Hsu, Sun, Lin & Sun, 2005; Lazar, Jones, Hackley & Shneiderman, 2006). Following the generally positive student evaluation of the perceived value of the online reflective journal on its introduction, it was retained as an assessable item in the unit for following semester offerings of SEB421.

Contribution to learning outcomes

A range of student demographic and reflective journal usage data were collected over three successive semesters of offer of SEB421, including the period of introduction of the online reflective journal. The data collected included:

- gender;
- age;
- mode of study (on- or off-campus);
- weighted average mark (WAM – a proxy for general prior academic ability);
- semester of offer cohort grouping;
- number of reflective journal entries posted (a proxy for ‘quantity’ of engagement);
- average mark per journal entry (a proxy for ‘quality’ of engagement);
- number of reflective journal entries read; and
- final unit mark (out of 100 – a proxy for unit learning outcome).

There was no significant difference between the proportions of gender and mode of study between the three semester cohort groups. There was no significant difference between the means of WAM, number of journal posts, number of journal entries read and final unit mark between the three semester cohort groups. Only mean age and average mark per journal post were significantly different between the three semester cohort groups. There was good consistency between the data characteristics of the three semester cohort groups, suggesting that they can be validly pooled to form a larger sample population for investigation. The differences between mean age and average marks per journal post were noted, should these characteristics turn out to be factors of importance in subsequent analysis. The pooled data represented 387 student data sets, and Table 5 presents a summary of the pooled data.

Table 5: Summary of pooled data characteristics

Gender	Male	88.9 percent	Female	11.1 percent
	Mean	Standard deviation	Minimum	Maximum
Age	25.07	5.67	20	49
Mode of study	On-campus	69.8 percent	Off-campus	30.2 percent
WAM	Mean (of 100)	66.31	Standard deviation	9.91
Number of posts	Mean	9.12	Standard deviation	2.08
Average mark	Mean (of 1.0)	0.95	Standard deviation	0.71
Number of post read	Mean	92.86	Standard deviation	95.88
Final unit mark	Mean (of 100)	69.74	Standard deviation	12.77

The positive contribution to learning outcomes of an online reflective journal has been noted previously (Xie et al., 2008). To investigate the contribution to learning outcomes of the data variables collected, multivariate linear regression was performed with 'final unit mark' as the dependent variable. All other data variables were initially introduced as dependent variables, and step-wise regression was performed until all remaining variables were significant. The resulting model regression residuals for the predicted variable were approximately normally distributed and there were no extreme outlier observations. Table 6 presents the variables and the corresponding coefficients of the linear regression model in order of contribution for the dependent variable 'final unit mark'.

Table 6: Multivariate linear regression model for the dependent variable 'final unit mark'

Variable	Coefficient	Standard error	Beta	Significance
Weighted average mark	0.805	0.049	0.624	$p < 1.2 \cdot 10^{-46}$
Number of journal posts	1.273	0.236	0.208	$p < 1.4 \cdot 10^{-7}$
Mode of study	-3.418	0.999	-0.124	$p < 0.0007$
Constant	7.127	3.204	-	$p < 0.027$

An Analysis of Variance (ANOVA) test suggested that the regression model is significant ($F_{386} = 144.179$, $p < 1.7 \cdot 10^{-62}$) and predicted 53.0 percent of the variation in the dependent variable ($R^2 = 0.530$). The standard error of predicted variable estimate from the model (8.79) was less than the standard deviation of all student final marks (12.77). The regression model explains just over half of the variation observed in the final unit mark; hence there exist other factors with a significant influence on student learning outcomes. Care must be taken in interpreting the multi-regression model literally as the formula for final unit mark; however, it does indicate those factors that contribute to student learning outcomes. The two variables that were previously noted as significantly different between semester cohort groups (mean age and average marks per journal post) were not found to be significant factors in the regression model. While there are 'other variables' that account for the other 47% of the variation in final unit mark, it is observed that:

- prior academic performance was an important predictor of final unit mark;
- the number of journal posts that a student made was an important predictor of final unit mark, and this was separable from WAM, and contributed at somewhat above the 'face value' of up to 1 mark per posting; and
- even though mode was not significantly correlated to final unit mark on a direct pair-wise basis, after the effects of WAM and number of posts were accounted for, mode became significant in accounting for some of the remaining variation in final unit mark, this being a negative influence for off-campus students.

It is perhaps not too surprising that by the (nominally) final semester (out of eight) of study for engineering and technology students that their WAM (based on the average result for 28 out of 32 units)

was a strong predictor of final unit mark. To reach this point in their studies, students have obviously developed successful and repeatable study strategies. As noted in Table 3 above, the most frequently reported 'most useful aspect of the online reflective journal' by students was the continuous revision of the study materials. Students valued the academic/cognitive aspect of the reflective journal, and this was supported by the presence of the variable 'number of journal postings' as a significant predictor of final unit mark. Its (somewhat) 'above face value' contribution to final unit, suggests that completion of reflective journal entries enhanced the students' academic performance in other elements of assessment for the unit. Mode of study was not observed to be significantly related to final unit mark on a pair-wise correlation basis ($r = -0.077$). However, after the effects of WAM and number of journals postings were accounted for, mode of study did become a significant (although minor) predictor of final unit mark, with off-campus study mode observed to have a negative impact on final unit mark. The cause of this effect is not known, and, for the purpose of the regression analysis, 'mode of study' was a binary categorical variable employed as a scale variable (with values of 0 and 1), so, this result should be interpreted with some caution. As noted in Table 2 above, virtually all students read the journal entries of other students, and, as noted in Table 3 above, the second most frequently reported 'most useful aspect of the online reflective journal' by students was the ability to compare their thoughts/reflections to those of other students. However, even though most students read and valued the posts of other students, the number of journal posts read was not found to be a significant predictor of final unit mark. In this case, the value attributed to reading the posts of other students may have been more perceived than real.

In a similar context (a formally assessed online discussion), the authors have previously made similar findings regarding contribution to unit learning outcomes, that is:

- student prior general academic ability was a significant contributor to final unit mark;
- number of postings to the online discussion was a significant, and 'above face value', contributor to final unit mark; and
- the number of postings read by a student was not a significant contributor to final unit mark (Palmer, Holt & Bray, 2008).

The findings of this research project (supported by previous findings in a similar context) suggest guidance for those considering the use of online reflective activities in their teaching. It appears that it is the activity of formally reflecting on learning that makes a contribution to student learning outcomes, rather than the act of simply reading the posts of other students. Although, student prior academic performance was a significant predictor of unit learning outcomes, the additional contribution made by each new reflective journal posting suggests that introducing an element of 'compulsion' for students to make journal postings, such as through attaching marks to journal postings, would be beneficial.

Conclusion

An evaluation was undertaken of student perceptions of an online reflective journal introduced for the first time in the fourth-year engineering management study unit SEB421. Questionnaire responses indicated that:

- a majority of students understood the purpose of the journal, and valued the journal in their learning;
- a majority of students did not access the journal more than once per week;
- a majority of students read the journal entries of other students, and indicated that this assisted their learning;
- the two most frequently reported 'most useful' aspects of the online journal were the 'enforced' continuous revision of course material, and the ability to compare their understanding of the course material with that of other students; and
- the two most frequently reported 'least useful' aspects of the online journal were related to problems associated with the use of the CMS.

While a majority of students indicated that they understood the purpose of the reflective journal, and the students' journal entries did show evidence of critical reflection on their learning; in terms of the most useful aspects of the journal reported by students, the opportunity to critically reflect on learning was ranked much lower than the opportunity to revise (that is, merely reflect on) their weekly study. For the small number of students who reported that they did not have a clear understanding of the purpose of the reflective journal, and to help all students to differentiate between simple journaling and critical reflection (both of which were desired in this exercise), following offerings of SEB421 included additional explanation of the purpose of the online reflective journal. Evidence was observed of the social aspect of reflective learning – most students reported reading the journal submissions of other students, and the

ability to compare one's thoughts with others was frequently reported by students as the most useful aspect of the online journal. There are opportunities to enhance this social aspect of the reflective journal by formalising it as part of the assessment process; perhaps requiring students to read and comment on the submissions of other students, and/or requiring students to develop more substantial journal submissions in small groups. A critical influence on the students' perception of the online journal was the usability of the CMS. Even though the CMS was generally rated by students as easy to use, it was most frequently reported as the least useful aspect of the online journal.

Based on a regression analysis of the factors related to student usage of the online reflective journal over three semesters, it was found that the significant contributors to final unit mark where:

- prior academic performance;
- number of journal postings; and
- mode of study.

The most frequently reported positive aspect of the online journal was the enforced continuous revision required by the reflective writing task, and this student perception was supported by the regression analysis results in that the number of journal postings was found to make a positive contribution to final unit mark. The second most frequently reported positive aspect of the online journal was the ability to read the posts of other students. However, the number of journal posts read was not found to be a significant predictor of final unit mark. In this case, the value attributed to reading the posts of other students may have been more perceived than real.

This research confirmed that transporting the written reflective journal into the online domain did indeed find fertile and productive territory in the landscape of educational technology, both in terms of student perceptions and contribution to unit learning outcomes.

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