

Application of reflective papers in civil engineering education: a case study

Ena K.A. Rahman†, Sri K.A. Rahman‡, Abdul A.M. Nor*, Soon J. Tan†, Yok H. Yap† & El-Said M.M. Zahran†

Universiti Teknologi Brunei, Gadong, Brunei Darussalam†
Universiti Brunei Darussalam, Gadong, Brunei Darussalam‡
UNITAR International University, Selangor, Malaysia*

ABSTRACT: The purpose of this study was to investigate the effect of reflection on students' performance and assessment in civil engineering. In this study, the students in the final semester of a civil engineering programme were divided into two groups: the first group was tasked with writing a reflective paper, and the second group, a control group, was not required to write a reflective paper. Both groups were then assessed through a test based on the content of a lecture. The data were analysed in two parts. The first part comprised examination of the content of the reflective paper and its impact on students' performance. In the second part, the performance of both groups of students was compared. A research hypothesis was specified and tested. The hypothesis was tested through two independent samples *t*-test to determine whether there was a significant difference in the mean result between these two groups of students. The study revealed that the use of reflection in civil engineering education potentially could improve students' performance.

Keywords: Higher education, reflective paper, reflection, civil engineering

INTRODUCTION

The theory of reflection [1] is a form of thinking as an aide to knowledge development [2]. In the Kolb cycle of reflective learning, reflection involves observing and thinking from experience [3]. From previous studies, it has been suggested that reflection helps knowledge development through deep thinking while reflecting on experience.

The use of reflection has been implemented in teaching, nursing and other professional occupations related to the social sciences [4-7]. However, the use of reflective practice has been only recently introduced into engineering education [8]. For some study programmes, such as civil engineering, the idea of introducing reflection as one of the learning tools is relatively new in Brunei Darussalam.

The current practice of reflection has been implemented as part of *Learning in the 21st Century* [9][10]. It is suggested that students' reflection can be part of a dialogue between students and teachers, to improve learning [11]. In addition, students' reflection has been a part of formative assessment, to improve the learning of students in schools [12].

Presented in this article is a study of integrating reflection into a civil engineering programme, and its impact on students' performance and assessment. The study subjects were 46 students who were in the final semester of a Higher National Diploma (HND) in a civil engineering programme. All the students shared the same material and information concerning a topic on foundation engineering. Half of the students wrote a reflective paper. At the end of this study, all students were assessed through a class test based on the content of lectures.

METHODOLOGY

The students were informed at the beginning of a class that half of them were required to write a reflective paper of no more than two A4-pages based on what they experienced and learnt during the lecture. However, the students chosen to produce the reflective paper were identified only at the end of the lecture, and they were required to submit the reflective paper on the next working day. On the day of submitting the reflective papers, all 46 students were given a class test without prior notice, based on the lecture topic. After the test, a short survey was carried out to obtain the students' feedback on the introduction of reflective papers in their studies.

DATA ANALYSIS

The data were analysed in two parts: the first examined the content of the reflective papers and their impact on students' performance. The reflections may differ depending on how the knowledge was absorbed.

The second part of the analysis was aimed at distinguishing the performance between the two groups of students during the test. To do this, a research hypothesis was specified and tested. It was predicted that the students' performance on the test improved when they participated in writing reflective papers.

A two-sample *t*-test [13] was applied, to determine whether there was a significant mean difference between these two groups of students. Hence, the null hypothesis was that there is no difference in the performance of students between groups. The null hypothesis would be rejected if the *p*-value was less than the significance level of 0.05. It should be noted that a one-tailed instead of two-tailed test was used as it is predicted that introducing a reflective paper will only have a positive impact on students' performance (or a zero impact if the null hypothesis was accepted) [14].

REFLECTIVE PAPERS AND THEIR IMPACT ON ACADEMIC PERFORMANCE

It was observed that there was a general misconception among students about the concept of reflective papers. Most summarised the content of the lecture only, without giving any thought to, or judgement on, their experiences while acquiring the knowledge. Nevertheless, the students' reflective papers were still useful, as they can be correlated with the students' performance in class.

The analysis of 24 students' reflective papers showed that the students discussed three subjects in their reflection, as presented in Table 1.

Table 1: Subjects in students' reflective papers.

Subject 1	General description of the students' learning experiences and the approach to teaching/learning
Subject 2	Limitations of the lecture and recommendations for future lectures
Subject 3	Description of what the students learnt in class

All students included what they learnt in class (Subject 3), but only six students added their learning experience (Subject 1). One student pointed out the limitation of the lecture and provided a recommendation that needs to be considered for future lectures. It was further observed that the depth of students' focus in explaining what they learnt in the class can be divided into three parts, i.e. the students either:

- 1) simply listed the outline of the topic;
- 2) reasonably described what they learnt, but only a few learning outcomes of the lecture were selected; or
- 3) thoroughly explained what they learnt in great detail, that included explanations aided by diagrams and equations.

The students' test results suggested that the students who thoroughly explained what they learnt in the lecture tended to score higher marks than those who briefly outlined the topic. However, it was identified that there was one case where a student achieved a relative low mark, i.e. 40 percent, even though a detailed reflective paper was produced. A summary of the relationship between the students' performance in the test and the depth of students' reflection is given in Table 2. Even though there was a slight discrepancy in terms of the students' performance, it was still observed that the performance of students (test result) closely related to how the reflective papers were prepared by the students.

Table 2: Relationship between the depth of students' reflection and performance in the test.

Depth of students' reflection	Number of students in the mark range of %			
	<40	40-59	60-79	80-100
Brief outline	1	6	0	0
Reasonable description	1	5	5	0
Detailed explanation	0	1	1	4

It can be argued that with reference to the previous study, the quality of a reflective paper may also depend on the time needed for the students to reflect on the lecture [5]. This is because reflection in learning involved time allowance for the students to organise their thoughts, process the content of the lecture, and reorganise and construct their understanding of the knowledge [1-3]. In this case, as the students were asked to submit the paper on the next working day, some students may not have had adequate time to prepare a thorough reflective paper.

REFLECTIVE VS NON-REFLECTIVE STUDENTS

Further analysis was conducted of the two groups of students, i.e. the 24 students who wrote a reflective paper and the 22 students who did not. This suggested that the students who wrote reflective papers performed better than those students who did not, as shown in Figure 1.

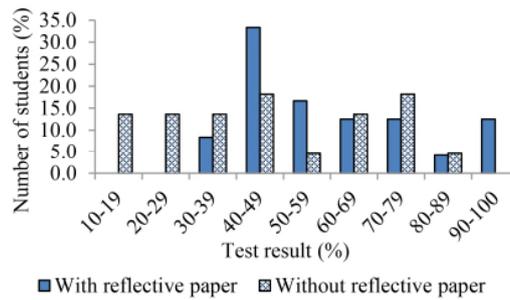


Figure 1: Marks distribution for the two groups of students.

Given the pass mark for the module was 50%, the group who wrote the reflective papers achieved a 58% pass rate with an average mark of 57.9% compared to the other group of students who achieved a 41% pass rate with an average mark of 46.2%.

A further review of the failed scores revealed that students who wrote a reflective paper and failed the test mostly had obtained marks in the 40-49% range and only two students obtained marks below 40%. However, the outcomes were opposite for students who were not involved in writing the reflective papers, as shown in Table 3.

Table 3: Students' performance in the marks range below 50% pass.

Marks range (below 50%)	Number of students and %	
	With reflective paper (%)	Without reflective paper (%)
40 – 49	80 (8 students)	31 (4 students)
< 40	20 (2 students)	69 (9 students)

The above result was supported by the statistical t -test, with a p -value of 0.03. This indicates that the null hypothesis for this study was rejected since the p -value is less than 0.05. This clearly shows that the difference in students' test performance between these two groups was statistically significant.

The overall result shows that the introduction of reflective papers for engineering students in higher education potentially could improve the students' performance. The introduction of reflective papers for 21st Century learning [9][10] is well supported by this study. Even though the focus of the reflective paper may vary among students, the results still demonstrate that these students produced better performance in the test compared to those who had not produced a reflective paper.

STUDENT FEEDBACK ON REFLECTIVE PAPERS

Some students initially gave a negative response to the idea of writing a reflective paper. A common concern was the additional workload required to write a reflective paper, adding to the number of assignments that the students needed to submit during the semester. Nevertheless, some of the students were curious and enthusiastically participated in the study.

After the test was conducted, the students commented that the idea of writing a reflective paper may contribute to a better understanding on the taught topic. They added that their experience in reflecting on the lecture may help them to perform better in their tests and assignments. It helped to structure their thinking, and hence construct their knowledge. It was observed that during the second cycle of writing a reflective paper (after the work in this study), students were more committed. From preliminary analysis of the second reflective paper, students appeared to be more engaged and had better understanding of the concept of reflection.

A subsequent survey of 32 students from this group showed that all respondents provided positive feedback on the idea of introducing reflective papers in their study. A selection of student feedback follows:

- *I can express what I did not understand during lecture so that the lecturer will be aware about the problem.*
- *I can tell the lecturer what I feel about the lecture so that she can improve if there is anything that needs to be improved.*

- *The reflective paper will be very useful since we tend to leave studying to the last minute; writing a reflective paper forces us to revise the topic which would probably make it easier for us in the long run.*
- *Reflective paper comprises the summary of the lecture. It helps me to highlight important points of the lecture.*
- *Reflective paper gives greater understanding towards the lecture content.*
- *It helps me to reflect back on what happened in the class; reflection paper indirectly acted like a self-revision after the class.*
- *When I wrote the reflective paper, it made me do further on-line research about the topic.*
- *I am sure that ongoing reflective activities help students to be more motivated and focused in the class because all of us know that at the end of the class we were asked to do a reflective paper.*

CONCLUSIONS

The rejection of the null hypothesis reveals that there is a statistically significant difference between students who wrote a reflective paper and students who did not write a reflective paper. The study demonstrated that, in addition to a lecture, the use of reflective paper in the civil engineering programme has improved the students' performance in the subsequent test. Moreover, it showed that the quality of the students' reflective paper, evaluated in terms of the focus, depth and the content of the subject area, also influenced the students' performance. Although some of the students initially were reluctant to participate in writing the first reflective paper, the students' subsequent feedback showed positive responses after the test was conducted. The students became more appreciative and better understood the usefulness of writing a reflective paper.

Despite the positive impact of reflective papers on students' feedback and performance found in this study, the effectiveness of reflective papers in other modules or other topics for the same module has not been evaluated. Thus, it is recommended for future work to expand this study using a similar approach with other engineering topics in the civil engineering programme. The study also could be improved by including comparison groups comprised of students with similar abilities or only focusing on students who had the same experience and opportunity to write reflective papers. Furthermore, in order to expand the use of reflection in engineering education, it is important to address the issue of students' general misconception of writing a reflective paper.

REFERENCES

1. Dewey, J., *How we think: A restatement of the Relation of Reflective Thinking to the Educative Process*. DC Heath and Company (1933).
2. Habermas, J., *Knowledge and Human Interests*. Beacon Press (1971).
3. Kolb, D.A., *Experiential Learning: Experience as the Source of Learning and Development*. Prentice-Hall (1984).
4. Turner, K. and Simon, S., *Portfolios for Learning: Teachers' Professional Development through M-Level Portfolios*. New Designs for Teachers Professional Learning, Bedford Way Papers. Institute of Education, University of London, 89-115 (2007).
5. Moon, J., *Reflection in Learning and Professional Development: Theory and Practice*. Routledge (1999).
6. Clark, B., James, C. and Kelly, J., Reflective practice: reviewing the issues and refocusing debate. *Inter. J. of Nursing Studies*, 33, 2, 171-180 (1996).
7. Schon, D.A., *The Reflective Practitioner: How Professional Thinks in Action*. Ashgate Publishing Limited (1991).
8. Hussin, H., Ramachandran, S.D. and Bakri, N., Reflective practice and professional development in engineering education. *The Inter. J. of Learning: Annual Review*, 16, 3, 465-476 (2009).
9. Kuhlthau, C., Maniotes, L. and Caspari, A., *Guided Inquiry: Learning in the 21st Century*. Greenwood Publishing Group (2007).
10. Glasson, T., *Improving Student Achievement: a Practical Guide to Assessment for Learning*. Australia: Curriculum Corporation (2008).
11. Groundwater-Smith, S., Listening to students. *The EBE J.*, 2, 18-20 (2008).
12. Moss, C.M. and Brookhart, S.M., *Advancing Formative Assessment in Every Classroom: a Guide for Instructional Leader*. Association for Supervision and Curriculum Development (2009).
13. Rasinger, S.M., *Quantitative Research in Linguistic: An Introduction*. Continuum International Publishing Group (2008).
14. Cohen, L., Manion, L. and Morrison, K., *Research Methods in Education*. Routledge (2007).

BIOGRAPHIES



Ena Kartina Abdul Rahman graduated with a Bachelor of Engineering in civil engineering from the University of Salford, United Kingdom, in 2000. She received her PhD in civil engineering from the University of Manchester, United Kingdom, in 2008. She started her career as a lecturer in civil engineering after the completion of her PhD and later became an Assistant Professor in 2017. Her general field of speciality is geotechnical engineering with specific interest in the fields of slope stability, soil-water relationship and landslides. She was awarded a Master of Teaching in Higher Education from Universiti Brunei Darussalam in 2013, where she also began to develop her interest in teaching and learning research in engineering education. She was the Deputy Dean (Academic) from 2014 until 2018, and at present is the Dean for the Faculty of Engineering.



Sri Kartika Hj Abdul Rahman is a lecturer at the Sultan Hassanah Bolkiah Institute of Education, Universiti Brunei Darussalam (UBD), since 2009. She obtained her first degree at UBD and Master of Education at the University of York, United Kingdom. She has been teaching modules for postgraduate and initial-teachers preparation programmes, such as teaching pedagogy, curriculum and assessment. She co-supervised a number of students from Master of Education and Master of Teaching. She also writes articles and book chapters on teaching and learning strategies.



Dr Abdul Aziz Md Nor began working as a teacher in 1982. He taught in a number of schools in the states of Sabah and Perak, in Malaysia. In 1997, he joined the Institut Aminuddin Baki, the Ministry of Education, Malaysia, where he conducted leadership training for school leaders at national level until 2009. Dr Aziz became a university lecturer at the Universiti TENAGA Malaysia in 2010; then at the Universiti Brunei Darussalam between 2010 and 2013; and with UNITAR International University (2013-2017). At present he is the Director for the Doctor of Education Programme at the Open University Malaysia.



Dr Tan Soon Jiann graduated with a Bachelor of Engineering in civil engineering from the University College London in 2001, and subsequently obtained a PhD from the same university with a thesis on *Modelling the foundations of idealised integral bridges in granular material*, in 2007. He began his academic career as a lecturer in civil engineering at the Universiti Teknologi Brunei, and was later promoted to a senior lecturer in 2012 and Assistant Professor in 2017. At present, he is Director of the Centre for Transport Research (UTB) and a member of the Brunei National Road Safety Council. Through active collaboration with local and regional road safety stakeholders, he has developed research experience and interest in the field of road safety and transportation geotechnics. He has successfully completed several university- and externally funded research projects in these fields, which have resulted in the publication of several peer-reviewed research papers.



Dr Yok Hoe Yap is the Deputy Dean (Academic) of the Faculty of Engineering, Universiti Teknologi Brunei (UTB). He is also a senior lecturer of civil engineering, and a researcher in the Centre for Transport Research of UTB. He has an MSc in transportation planning and engineering and a PhD from the University of Southampton, obtained in 2011 and 2015 respectively, while his MEng in civil engineering and associateship of the City and Guilds of London Institute were obtained in 2002 from the Imperial College of Science, Technology and Medicine, London, UK. During his term as Programme Leader for Civil Engineering, and as a graduate member of the Institution of Civil Engineers, he helped UTB achieve the accreditation of its civil engineering BEng and MSc programmes by the Institution of Civil Engineers (ICE), the Institution of Structural Engineers (IStructE), the Chartered Institution of Highway and Transportation (CIHT) and the Institute of Highway Engineers (IHE). He

was a runner-up for the Smeed Prize (Universities Transport Study Group) in 2015 for transport research, and contributes frequently as part of the Brunei Darussalam National Road Safety Council, particularly in the Research and Development Action Group. His research interests include highway and traffic engineering, particularly in the field of microscopic simulation.



Dr El-Said M.M. Zahran graduated with a Bachelor of Civil Engineering (Hons) from Cairo University, Egypt, in 2000, and completed his Master of Science in civil engineering from Cairo University, Egypt, in 2005. He obtained his PhD in civil engineering from the University of Nottingham, UK, in 2010. At present Dr Zahran is an Assistant Professor in civil engineering and the Deputy Director of the Centre for Transport Research at Universiti Teknologi Brunei, Brunei Darussalam. He worked previously as an Assistant Professor in civil engineering at both Imam Muhammad ibn Saud Islamic University in Saudi Arabia and Ain Shams University in Egypt. He was a teaching assistant in civil engineering at the University of Nottingham, UK. His research interests are traffic safety, geographic information science, transport engineering, pavement engineering and air quality management. Dr Zahran is a member of the Institution of Civil Engineers and the

Engineering Council in the UK. He is also a chartered engineer at the Syndicate of Engineers in Egypt. He is listed in 14 *Who's Who* encyclopaedias, including the Marquis *Who's Who* in the World, for his contributions to teaching and research in civil engineering.