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Learning Hydraulic Engineering from Site Visit and Open Book Assessment

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Abstract

Due to the introduction of computer based program and reduction of face-to-face contact hours, many higher education institutions are cutting site visits and field works from their curriculum. But engineering is an applied science to the real-world problems and the engineering education needs hands-on training. Because of this, fieldworks and site visits are essential components of engineering course curricula. Upon completion of lecture on dam engineering, a visit to a dam site was conducted for final year civil engineering students, which was followed by an open book assessment after one week of visit. In order to investigate the student learning on hydraulic engineering from site visit and its subsequent open book assessment, a questionnaire survey was conducted after the open book test. The survey instruments consist of two sections. One section has 9 questions on student learning from site visit and second section consists of 10 questions on learning from open book assessment. The results revealed that students are motivated (87% agreement; n=39) for site learning because it provides work-integrated learning experiences (also 87% agreement; n=39). It also shows that an open book assessment is an excellent way of learning to be a professional engineer (92% agreement; n=48). Student performances on site learning show that 78% of the students got mark more than 70% in the test achieving significant learning outcomes. This also indicates that the open book assessment motivates students' independent learning but there is a need to train students what information they need to bring because many of them found wasting times flipping through the site visit notes/books.

Keywords: Student, Learning, Site visit, Assessment, Open book.

1. INTRODUCTION

Hydraulic engineering is a core unit in undergraduate civil engineering course curriculum. It covers fluid mechanics, open channel flow, pumping systems, water distribution systems, sediment transport and hydraulic structures. In order to gain hands-on learning experiences, undergraduate laboratory experiments are conducted in engineering study. Laboratory experiments may provide some practical feelings but complete understandings for real-life situation remains unresolved until they go for a site visit. Many reviews have been taken place in last few decades in higher education sectors to reform engineering course curriculum. But most of the cases, it focused on the content of the subject materials and its employment opportunities in engineering industries **(**Sparkes, 1993; Simmons, 1995; Elms, 1992; Ditcher, 2001). One of the suggestions is made to improve student motivation by incorporating more problem based education. But this can happen when the learning experience is more towards student-centred rather than teacher-centred. One way of achieving this by adopting blended learning approach in teaching. For example, Rahman (2017) used this approach to teach fluid mechanics in engineering (Rahman, 2017) and Anwar (2011) used student feedback-based blended teaching in civil engineering hydraulics. But to provide more student-centred learning experiences in a practical situation, it is necessary to send students for site visit, especially for hydraulic engineering.

In many countries, it is a very common trend to cut the contact hours in case of budget constraints (Russell et al., 2000; Liggett and Ettema, 2001). This has been justified by introducing computer-based courses and virtual teaching, project-based subjects, and management courses but excluding practical studies and fieldwork (Chanson, 2000-04). The integration of technology in teaching has led to e-learning, distance learning, mobile learning and/or virtual learning. Many class rooms (lecture theatres) in the universities of developed countries are equipped with Echo360 and iSmart cameras which provide direct iLectures published in the online learning platform-Blackboard for all registered users. These online resources can provide learning experiences in virtual domain but fails to provide the feeling of actual world. The limitations of online based learning resources are explained in Chanson (2001, 2004) where he emphasised for site visit especially for hydraulic engineering.

Next, assessment and feedback mechanism are important aspects for student learning. Closed book examination is an established method of traditional assessment. The main purpose of assessment is to grade student abilities and to provide feedback. But one may argue that the open book assessment provides deeper learning (Cnop and Grandsard, 1994) and powerful contribution to student learning at higher taxonomical levels (Eilertsen and Valdermo, 2000). This is more logical for engineering units because professional engineers do not solve the problems closing the books. They use multiple resources (including design code and handbooks) to solve engineering problems. Open book test is a process of testing student understandings of real-life situations where considerable resources are available rather than recall or memorization (Feller, 1994). In order to produce work-ready graduates, open-book quizzing and examination may help preparing engineering students in a better way for the real-world operational situation where they need to take decision immediately.

In this study, student learnings from site visit and its subsequent open book assessment are investigated. The results are discussed to show how a field visit to a dam site and its subsequent open book assessment provide adequate student learning experiences in undergraduate civil engineering.

2. METHODOLOGY AND DATA COLLECTION

2.1 The unit - water systems and structures

The unit - water systems and structures is an optional civil engineering unit for final year students at Curtin University, Western Australia. This unit has two parts-hydraulic structures and water distribution systems. The prerequisites of this unit are pumps and open channel flow and hydrology and environmental engineering which are taught in the third year level. The part hydraulic structures mainly consist of dam and other structures such as weirs, spillways, culvert and stilling basins. The major portion of hydraulic structures are taught as dam engineering and its necessary components such as, drainage gallery, spillways, weirs and stilling basin. This part of the unit is taught in the first four weeks of the semester. All necessary background theories, their respective design aspects, maintenance and operation procedures are discussed in the lectures and tutorials. The lecture materials are uploaded onto the online learning management system-Blackboard at the beginning of the semester so that the student could come to the lecture looking into the learning resources before coming to the class. The lectures are carried out demonstrating the theories followed by practical design examples. The whole learning sessions are recorded (audio, powerpoint slides and video of lecturer in white board demonstration) in Echo 360 and published as iLecture in the Blackboard. All users of this unit have the online access to Blackboard and view the iLectures.

2.2 The visit to a dam site

In order to provide a work-integrated learning experience, a site visit to Victoria dam in Western Australia was organised following the completion of lecture on hydraulic structures. This dam was selected because it is closer to Curtin and consists of many structures covered in the lecture. This dam is managed and operated by Water Corporation, a state Government organisation of Western Australia. Victoria dam is located 25km south-east of Perth and situated on the Darling Scarp near Lesmurdie, and crosses Munday Brook. This is the new concrete gravity dam constructed in 1991 following the demolition of older dam located in the same place. The first Victoria dam was constructed in 1891 and was the first source of water supply in the Perth's city. But the original dam fails to maintain its safety measures especially in terms of flooding and earthquake loadings and because of this, it was demolished in 1990 using explosives. The Victoria dam is slightly upstream of the old dam. Different dimensions of the dam are as follows: crest length=285m, spillway=130m, crest width= 8.7m (non-overflow section), 1.7m (above the spillway). The dam collects stormwater in a reservoir of 9.5Mm^3 from a catchment area of 37 square kilometre. Different components of this dam include dam foundation, dam wall, intake tower, spillway, drainage gallery, and stilling basin. The downstream side dam wall consists of numerous steps that may help dissipating energies in the case of overflowing. The drainage gallery is located inside the dam body that provides the opportunity to monitor the dam performance and measure the seepage water. The seepage water measurement is an important part of dam operation. This is because the seepage water reduces the uplift pressure and thus reduces the overturning moment of the dam.

The visit was conducted in teaching week five of semester one 2016. An agreement has been signed between Curtin and Water Corporation for this site visit. A preliminary risk assessment (low risk) was prepared for this site visit and an approval was taken from the work-integrated learning (WIL) coordinator of Curtin University. The students were taken to the site by a rented bus. It took approximately 30 minutes to reach the site. Three guides from Water Corporation explain about the design, construction and operation and maintenance of the dam. The students were shown the original design and were given the opportunity to see the intake tower in a group (8 in one group). This was guided by the operational engineer of Water Corporation. The guides showed them the spillway and dam wall and explained why cracking is critical in a concrete dam. Next, they were taken inside the dam to visit the drainage gallery and to see how the pore-water pressure is relieved through the galleries to reduce the uplifting pressure. Finally they explained about the stilling basin how it is used to dissipate the hydraulic energies in case of overflowing the spillway. The dam tour took two hours and during this time, unit lecturer asks different questions to the students and the guides so that the student could link with the dam design and maintenance what they have learned in the lectures.

2.3 Data Collection

One week after the site visit (week 6), a quiz test on site visit was organised in open book format. The open book format test was introduced in this unit with the assumption that professional engineers do not solve the problems closing the book or necessary manuals. In order to investigate the student learning experiences from the site visit and subsequent open book assessment, a paper based anonymous questionnaire survey was conducted just after the test. Anwar (2012) reported the student learning experiences from a site visit but he did not identify any student motivation or work-integrated learning experiences from the site visit. In this study, Anwar (2012)'s questionnaire survey list was revised to incorporate these items. In addition, a new questionnaire survey was conducted on open book assessment. These survey questions consist of both quantitative and qualitative items. The quantitative items in questionnaire survey include 9 questions for site visit and 10 questions for open book assessment. These quantitative items are asked to answer similar to Curtin University online evaluating system-eVALUate which include *Strongly Agree (SA), Agree (A), Disagree (D), Strongly Disagree (SD) or Unable to Judge (UJ)*. The quantitative items may be summarised in terms of different learning instruments. For site visit questionnaires, these include deep understandings (Q1-Q4), assessment (Q5), motivation (Q6), learning outcome (Q7), WIL (Q8) and satisfaction (Q9). For open book assessment questionnaires, the learning instruments include motivation (Q1-Q3, Q6-Q7), assessment (Q4-Q5, Q8), WIL (Q9) and satisfaction (Q10). Out of 51 student enrolled in this unit in 2016 at Bentley campus of Curtin University, 39 students took part in the survey for site visit and 48 students participated in the survey for open book assessment. Students participated in this survey anonymously and also put their qualitative feedback if they wished to do so. The difference in student participation in questionnaire survey was because of the survey sheet printed both side. It seems some of them did not notice that it is printed both sides though it was announced.

3. DATA ANALYSIS AND DISCSSION

3.1 Student feedback on site visit

The student feedback on site visit was collected using a paper based structured questionnaire survey. Student put their feedback by ticking the most appropriate in *Strongly Agree (SA), Agree (A), Disagree (D), Strongly Disagree (SD) or Unable to Judge (UJ)*. The survey results are shown in Fig. 1. All

Strongly Agree and Agree were added together to express as parentage of agreement and all *Disagree, Strongly Disagree* feedbacks were added to get the percentage of disagreement. The results revealed that the maximum agreements (97.43%) were achieved for Q3 and Q9 respectively. It means that the lecture materials on dam engineering provided to the students were sufficient for them to understand the different aspects of a dam (Q3) and they were satisfied overall with the outcome of the site visit (Q9). However, agreements for items varied between 82-97% except the item in Q5 (76%). This item is related to the assessment of quiz test on site visit. Though this item is little low but the students' performance is fairly satisfactory (see section 3.4). However, the average agreement in all items was 88% while the average disagreement was 10%. The average agreement in different learning instruments such as deep understandings (Q1-Q4: 90.38%), assessment (Q5: 76.92%), motivation (Q6: 87.17%), learning outcome (Q7: 82.05%), WIL (Q8: 87.17%) and overall satisfaction (Q9: 97.43%) confirm that site visit in hydraulic engineering provides significant student learning. The individual analysis of each item revealed that item Q2 (*I could see the practical application of theories that I learned in the lecture)* received the highest *strongly agreement* feedback (43.58%) while item Q3 (*The lecture materials on dam engineering are sufficient to understand the different aspects of a dam*) received the maximum *agreement* feedback (66.67%). This clearly shows that the lecture materials and the knowledge they gain from the lectures provided meaningful learning outcomes when they see in practice. Many of the qualitative feedbacks revealed that *they were happy to see the theory in action* and suggested *more field visits in engineering curriculum*.

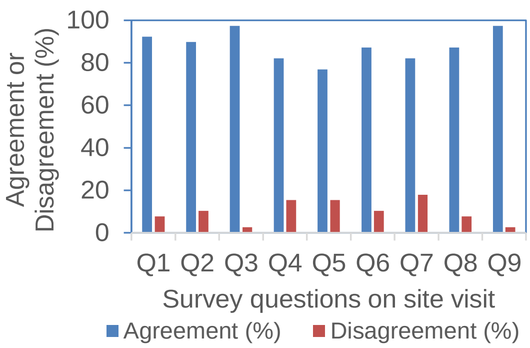

Fig. 1. Student feedback on site visit (n=39)

3.2 Student feedback on open book assessment

The student feedbacks on open book assessment were collected using a similar structured questionnaire. All feedback *in strongly agreement* and *agreement* are added together as percentage of agreement and similarly all *strongly disagreement* and *disagreement* items were added to get the percentage of disagreements and shown in Fig. 2. The results revealed that the percentage of agreements varies between 80.85-97.91% with highest agreement in Q1 (*Though the information are right there for me to look up, but still I need to study for an open book exam).* All percentages of disagreement were below 20% with a maximum disagreement (16.67%) in Q2 *(The open book exam is more challenging because it requires more critical and analytical thinking).* The minimum disagreement (2.08%) was found in Q1 and Q10 (*Overall, I am satisfied with this open book assessment).* The maximum *strongly agreement (62.5%)* was obtained in Q1 and *agreement (58.33%)* was in Q5 (*It tests your ability to find and use information for problem solving, and to deliver well-structured and well-presented arguments and solutions)*. The overall result presents in terms of different learning indicators such as motivation (Q1-Q3: 80.85-97.9%, Q6-Q7: 85.1-89.5%), assessment (Q4-Q5: 85.58-100%, Q8: 85.1%), WIL (Q9: 91.48%) and satisfaction (Q10: 97.74%). The agreement of hundred percentage in Q4 (*It tests your ability to find and apply information and knowledge in a limited time)* indicates that the limited time is a major factor for the performances in an open book test. The high percentage of agreement (91.48%) in Q9 (*Open book exam is an excellent way of learning to be a professional engineer*) shows that open book test provides them an experience to be a professional engineer which is also a form of work-integrated learning. Most of the students had positive views about the open book test as because they do not need to memorise the unnecessary stuffs (such as handbooks or standards) which they can bring to the test. The survey results clearly show that they can concentrate more on critical thinking and evaluate their own knowledge achieving deep learning. This also reduces stress of exam by not memorising the too many items of the syllabus.

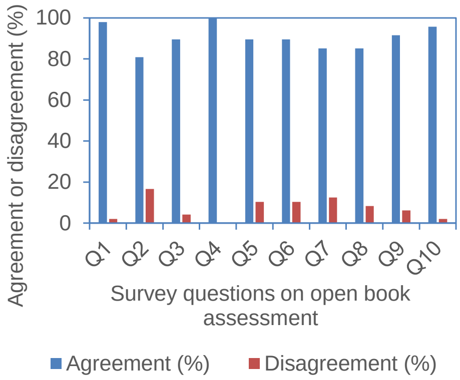

Fig. 2. Student feedback on open book assessment (n=48)

3.4 Student performances in open book assessment on site visit

The open book test on site visit was held for 40 minutes. The questions were put to test their deep understandings about the dam theory and its practical application onsite. The student performances on site visit presented in Fig. 3 are showing expected normal distribution. The results show that 90% of students got marks above 60%, 78% of student got above 70% and 45% student got above 80% of marks. These performances revealed significant student learning outcomes from site visit and open book assessment.

The results revealed that the site visit is an essential component which should be incorporated in engineering curriculum. The open book assessment may be suitable for 4th year engineering units where it needs knowledges from previous years. But it was found in this study that many students were searching information from the site visit handouts/books. The main objective of site visit was to establish link between classroom learning and site learning so that the students can understand clearly what they are learning, why they are learning. The open book test on site visit was to evaluate whether the students could understand the relationship between class room learning and site learning. In a closed book situation, the students are required to collect and memorise the information from the lecture materials and the teacher. But in open book exam, students need to know beforehand which material they need to bring to the test. This requires in-depth study of the materials and verification in the site. The students should take notes while listening to the guide onsite and later, they should cross check with the iLectures about their understandings. Sometimes it may become more challenging in open book test to find the most appropriate information if they are not well prepared. For this reason, training sessions may be organised for the students about what information they should bring to open book test. This is also a part of university learning process about what important materials they need to collect (such as, handbooks or standards) before solving/designing a particular engineering problem.

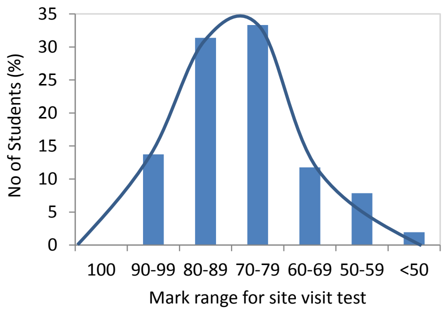

Fig. 3. Student performances on the site visit test (open book assessment)

4. CONCLUSION

In this study, learning hydraulic engineering was investigated through a guided field trip to a dam site and a subsequent open book assessment. Structured questionnaire was prepared for both items (site visit and open book test) and paper based questionnaire surveys were conducted after the open book test in the following week of the site visit. Most of the learning instruments on site visit such as deep understandings (90.38%), motivation (87.17%), learning outcome (82.05%), WIL (87.17%) and overall satisfaction (97.43%) confirmed that the site visit provided significant learning outcomes in hydraulic engineering. On the other hand, most learning indicators for open book assessment such as motivation (80.85-97.9%), assessment (85.1-100%), WIL (91.48%) and satisfaction (97.74%) also confirm significant learning outcomes through open book assessment. These results revealed that the students can see theory in practice onsite and the open book assessment provides less anxiety of memorising the theory and unnecessary stuffs (standard or handbooks). This is confirmed by the student performances which show more than 78% of students getting marks above 70%. Though significant student learning outcomes were achieved through the site visit and open book assessment, but students still need some training for prioritising the most appropriate notes that they should prepare and bring it for open book assessment.

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