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The role of site visit in learning Hydraulic Engineering

A. H. M. Faisal Anwar[1]

Department of Civil Engineering, Curtin University, GPO Box U1987, Perth WA 6845, AUSTRALIA

Abstract. This paper demonstrates the role of site visit in the process of learning hydraulics in a 4th year undergraduate Civil Engineering unit (optional unit, prerequisite-pump and open channel hydraulics) at Curtin University, Western Australia. The unit is divided into lectures and a site visit. Victoria Dam site in Western Australia was chosen for this purpose because the site is a combination of different structures taught in the lectures and closer to Curtin. Three guides from Water Corporation (owner of the dam) explained different aspects of dam to the students. In a week after the visit, the students sat for a test on the field trip where they were asked to answer 8 questions. An anonymous questionnaire survey was conducted immediately after the test where they were asked to put their level of agreement with statements about (i) their motivation and learning hydraulic engineering from the site visit (ii) overall learning outcome from the site visit, (ii) assessment of learning hydraulic engineering from site visit (iii) coordination of the site visit and (iv) their overall satisfaction. The results revealed that the overall satisfaction of learning hydraulic engineering from site visit was 80%. The average agreement for all the items was found 72%. The most agreements (79-88%) were found for their motivation and learning process of hydraulic engineering from the site visit. The least agreement (42%) was found for the method of assessment for site visit but their assessment test results shows that more than 62% of the students could obtain >70% marks with an average marks of 74%.

Keywords: Learning, Students, Site visit, Teaching, Hydraulics

1. Introduction

Engineering is an applied science and engineering graduates must be familiar with the application of engineering theories that they learn in undergraduate classrooms. In order to be familiar with the practical application of the theories, there is no alternative other than the field visit. Laboratory experiments may provide similar concept but complete understanding remain unresolved. In last few decades, engineering curricula have been revised in every higher education institutions but these mainly tended to focus on the subject content of degree courses, and its relevance to the needs of engineering employers. There is also a common practice in the developed countries for making cost cuts that have led to a general trend toward reduction of formal contact hours [1-2]. This tendency has been associated with the development of computer-based courses and "virtual teaching," project-based subjects, and management courses, often at the expense of practical studies and fieldwork [3-6]. The technological development has focused more on e-learning, distance learning, mobile learning and virtual learning. For example, classroom lectures are published online as i-lectures in many universities of developed countries which have diverted students towards the non-attendance of classroom lecture physically. The addition of these technologies brings the students to learn quicker than the traditional classroom lecture but the overall learning still remains within classroom or virtual domain which does not provide the feeling of the real world. This situation has been properly addressed by Chanson [6] where he reported that most of the published papers in engineering education are focused on the e-learning, virtual teaching and project-based learning. Chanson [4] was the first to address the need for field trip learning in undergraduate engineering curriculum especially in hydraulic engineering. Civil engineering hydraulics consists of too many formulas and equations. Students usually do not feel comfortable to look into these formulas when they do not see any real-life application.

[1] *Email*: f.anwar@curtin.edu.au

Solving examples in the classroom does not provide such understandings of practical feelings. The site visit can fulfil this gap in learning process and develop a clear link between the theories and practice which may be considered as an integral part of the teaching pedagogy.

In this paper, the role of site visit in learning hydraulic engineering has been demonstrated as a part of the requirement in a 4th year optional unit in civil engineering curriculum at Curtin University, WA. Those students passed pump and open channel hydraulics in 3rd year civil engineering are eligible to take this unit. A visit to a dam site was arranged at the end of lectures and a test on the site visit was undertaken. An anonymous questionnaire survey was conducted just after the test about their learning process from the site visit and the results are analysed to reflect how a field visit enhances the overall learning process in hydraulic engineering.

2. The unit Water Engineering 465

The unit Water Engineering 465 is a 4th year optional unit for civil engineering undergraduate students at Curtin University, Western Australia. The prerequisite for this unit is the Water Engineering 361-Pump and open channel hydraulics. The students taking Water Engineering 465 are assumed that they already learned the fundamentals of civil engineering hydraulics and this unit is mainly designed for the application of hydraulics into practice. This unit syllabus covers water distribution system and their operation and maintenance. Several hydraulic structures are taught in this unit which are used in water distribution system or preservation include dams, weirs, sluice gates, spillways, culverts and stilling basins. The design methods of all of these structures are discussed in the lecture and a design problem for each case are solved in the lecture room in the form of project-based or group-based learning. The outcome from classroom learning is found to be not adequate because it does not provide the practical feeling of the structures. In order to provide such a practice-based learning experience, a field visit to dam site is organised at the end of the lecture. Dam site is selected because student can see the combination of most of the structures that they learned in the lecture.

3. Teaching Hydraulic Structures

The lectures on hydraulic structures are delivered in a flexible mode. This include uploading the lecture materials onto the university-wide online learning platform “Blackboard” well ahead of the lecture time assuming that the student could go through the specific lecture materials before the actual lecture occurs. This helped them to follow the lecture effectively. Each lecture is also available online in the form of i-lecture where the student can view the power point slides and listen to the audio of lecture. This provides more flexible learning environment for students especially for those who are unable to attend the lectures due to their other commitments. In the class room, each lecture was followed by a tutorial session where the students solved practice-based problem in a group. This enhanced the students to develop their team building and critical thinking ability. Lecturer walked around the table to help them where they faced difficulties. In this form of teaching and learning method could provide a sound theoretical background about each of the hydraulic structures taught in the class room but fails to provide the real feeling of the structures in the field. In order to fulfill this gap, a site visit is listed in the unit outline as a part of the learning activities for this unit.

4. Victoria Dam Site

Victoria dam site in WA was selected because the site covers most of the structures taught in the lectures and it is located near to Curtin as shown in Fig 1. The original Victoria Dam located 25km south-east of Perth was completed in 1891 which was the first source of water supply in Perth's city. But this dam was failed to maintain the proper water availability and pressure and there was a high incidence of typhoid in the city due to the poor water quality. It is believed that the poor sanitation, contaminants from animal husbandry and grazing activities were the main sources of water pollution. The structural deficiency was also observed and remedial measures were undertaken such as, increasing the spillway capacity and reducing the seepage through the dam wall. The seepage was leaching lime and thus reducing the strength of the concrete and forming voids [7]. In 1966, a major remedial works were undertaken for seepage reduction such as, a reinforced concrete upstream facing was installed to reduce seepage through the wall. A drainage system was installed to intercept any water leaking past the new facing [7]. In a safety review in 1988, it was concluded that the Victoria dam did not meet the acceptable limits of safety in terms of flooding and earthquake loadings. The concrete of the dam was of poor quality and the dam was decommissioned and partially demolished in 1990 using explosives. Only sufficient portions of the wall were removed to allow free passage of flood overflow from the upstream New Victoria Dam. The remainder (and majority) of the original dam has been preserved as a relic of Perth's first water supply. The new Victoria Dam was built in 1991 just upstream of the old dam. The main purpose of this dam is to supply water to the adjacent hills suburbs of Lesmurdie and Kalamunda and to augment supplies of water to the Perth metropolitan area during times of peak demand. The dam has a catchment area of 37 square kilometres and a reservoir capacity of 9.5 million cubic meters. The new Victoria dam is a roller compacted gravity dam rising approximately 35m above stream invert. The crest length of the dam is 285m, including a 130m long overflow spillway section. The crest width in the non-overflow section is 8.7m and is about 1.7m above the spillway crest. The different parts of the dam include dam foundation, dam wall, intake tower, spillway, drainage gallery, and stilling basin. The galleries allow for inspection of the dam body, provide an interior location for instrumentation used to monitor the performance of the dam and provide a collection point for drainage works. The seepage water collected in the galleries is drained out to the stilling basin from the gallery through a RC pipe.

5. Site visit and Data Collection

At the end of lecture on hydraulic structures, a field visit was organized to Victoria dam site. Seventy six out of 79 students went to the site and only 3 could not manage to join because of their personal commitments. Students were taken by two buses and it took 30 minutes to reach the site from Curtin. The site visit took place for two hours and three guides from Water Corporation (owner of the dam) helped students understanding different aspects of the dam. The guides explained about the history, construction and maintenance of new Victoria dam including dam foundation, dam wall, intake tower, spillway, drainage gallery, and stilling basin. The concerned lecturer asked several questions related to the dam construction and management perspective from which students could link their classroom learning to site learning. Though most of the learning outcomes of the unit are already achieved theoretically in the classroom but site visit provided more confident to the students about what they learned and how they are going to apply as a professional engineer. After one week of the visit, students sat for a test on the site visit where they were asked to answer 8 questions. Each of these questions is related to their understandings of the background theories and their application in practice about different hydraulic structures visited in the dam site. A paper based anonymous questionnaire survey on site visit was conducted immediately after the test (Table 1). The survey has 8 quantitative and one qualitative item. The quantitative items ask students to report their level of agreement with statements about (i) their motivation and learning hydraulic engineering from the site visit (items 1-4), (ii) assessment of learning hydraulic engineering from site visit (item 5), (iii) overall learning outcomes from the site visit (item 6) (iv) coordination of the site visit (item 7) and (v) their overall satisfaction about the visit (item 8). The anonymous answering style was used similar to the Curtin University online evaluating system-"eVALUate" [8]. Students may indicate Strongly Agree, Agree, Disagree, Strongly Disagree or Unable to Judge for each item. In addition, students are invited to put constructive comments on the qualitative item in order to improve learning outcomes from the site visit. The survey was a volunteer participation and 62 out of 79 students took part in the survey.

6. Data Analysis and Discussion

Anonymous student feedbacks were collected using the structured questionnaire. The data are analysed and percentage of agreement or disagreements are shown in Fig. 2 for different questions asked. The detailed results are shown in Fig. 3 for different questions. The results revealed that the level of agreement with the statements related to the motivation and learning hydraulic engineering from the site visit (Q1-4) was 58-88%. The most agreement was for Q1 which indicated that the student could understand the basic theory and their proper application in dam engineering. The agreement level of Q3 (58%) indicates that about 40% of the student think about the lecture materials supplied online is insufficient. This result fairly coincided with the percentage of absent students in the lecture. The main reason of these absentee was the late hours lecture schedule for this unit (5-8pm). However, level of agreement of overall learning outcome (Q6) was found to be 70%. The level of satisfaction on the trip coordination and the overall satisfaction on the field trip was 84% and 80% respectively. The average satisfaction on all the items was found 72%. The least agreement was found for assessment taken (Q5) for this field trip (42%). This percentage of agreement was low because of high percentage of student absentee in the lecture (about 40% as mentioned above). But the results of the quiz taken on the field trip revealed that more than 62% of the students could obtain >70% marks with an average marks of 74%. The overall marks for this quiz test obtained by the students presented in Fig. 4 showing normal distribution. This kind of statistical distribution is often expected in most cases of student performances. Though the field trip component is only 10% of the unit (Water Engineering 465) but it shows that the pass rate on this component is 98%.

The results on the qualitative item and discussing with the students after the site visit, it was revealed that one of the most important issues of the field visit for effective learning is the professional guidance during the visit. For example, students usually need expert guidance and knowledge to comprehend all aspects of a prototype design such as dam. In this visit, three guides from Water Corporation (one from the construction, one from operation and one from maintenance of the dam) together with the lecturer conducted the whole visit and presented all aspects of the dam. This process of field demonstration ensured the whole range of learning instruments starting from theory to design, construction, operation and finally maintenance of the dam. Those students could not attend this guided tour but conducted the visit of their own; their assessment result was found poor. This indicates that they learn little and missed out many important issues. This was also observed when they came to the lecturer to understand different aspect of the field visit. Hence it is important to note that an expert supervision is necessary to gain firsthand knowledge from the site visit [6].

Table 1 Questionnaire survey on learning hydraulic engineering from site visit

Quantitative items

1. From this field visit, I could understand the purposes of implementing a dam
   (i) Strongly Agree (ii) Agree (iii) Disagree (iv) Strongly Disagree (v) Unable to Judge
2. I could see the practical application of the theories that I learned in the lecture
   (i) Strongly Agree (ii) Agree (iii) Disagree (iv) Strongly Disagree (v) Unable to Judge
3. The lecture materials on dam engineering are sufficient to understand the different aspects of a dam.
   (i) Strongly Agree (ii) Agree (iii) Disagree (iv) Strongly Disagree (v) Unable to Judge
4. I could learn dam engineering more effectively through this field visit.
   (i) Strongly Agree (ii) Agree (iii) Disagree (iv) Strongly Disagree (v) Unable to Judge
5. The test taken is adequate to assess my understandings that I learned from the field trip
   (i) Strongly Agree (ii) Agree (iii) Disagree (iv) Strongly Disagree (v) Unable to Judge
6. Field visit to the dam site helps me to achieve the overall learning outcomes of this part of the unit.
   (i) Strongly Agree (ii) Agree (iii) Disagree (iv) Strongly Disagree (v) Unable to Judge
7. Coordination of the field trip was appropriate
   (i) Strongly Agree (ii) Agree (iii) Disagree (iv) Strongly Disagree (v) Unable to Judge
8. Overall, I am happy with this field trip
   (i) Strongly Agree (ii) Agree (iii) Disagree (iv) Strongly Disagree (v) Unable to Judge

Qualitative item

How do you think the field trip might improve your learning outcomes?

Fig. 1 Victoria dam site in Western Australia [7]

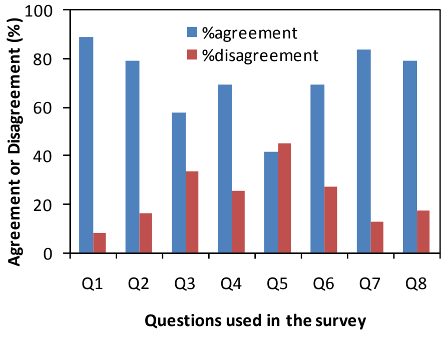

Fig. 2 Percentage of students' feedback

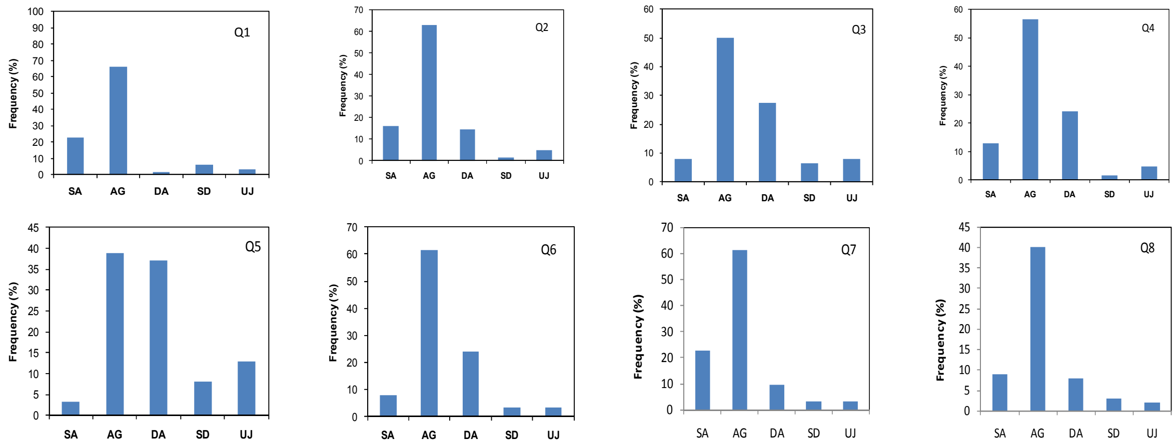

Fig 3 Detail Survey results for different questions

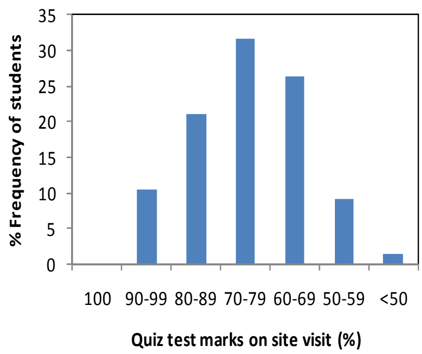

Fig. 4 Marks of the quiz test on the site visit

7. Conclusion

Site visit is an essential part for engineering education because Engineers bring theories into practice. But often the funds for site visit are cut in the higher education sector and more emphasis is given on e-learning, virtual learning or distance learning. Such e-learning platform can be integrated in engineering education but should not be replaced with site visit especially in case of hydraulic engineering unit. This paper demonstrated the role of site visit for learning hydraulic engineering in undergraduate civil engineering course. A guided field visit was organized for this unit and a structured anonymous questionnaire survey was conducted after the visit. Students' feedbacks were collected mainly on their level of agreement with statements about their motivation and learning hydraulic engineering, assessment of learning hydraulic engineering, coordination of the site visit and their overall satisfaction. The overall satisfaction of learning hydraulic engineering from site visit was found 80% with an average agreement for all the items 72%. The most agreements (79-88%) were found for their motivation and learning hydraulic engineering from site visit. Though the least agreement (42%) was found for the method of assessment but the quiz test on site visit results show that more than 62% of the students could obtain >70% marks with an average marks of 74%. However, the qualitative survey results indicate that a site visit needs to be conducted under professional supervision in order to obtain required learning outcomes.

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