Learning surveying and developing fieldwork skills through workshop

Anwar AHMF[1], Awange J[2], Nikraz H[1] and Ehsan F[3]

[1]*Department of Civil Engineering, Curtin University, Western Australia*
[2]*Department of Spatial Sciences, Curtin University,* Western *Australia*
[3]*Geodesy and Geoinformation, Bonn University, Bonn, Germany*
Corresponding Author's Email: f.anwar@curtin.edu.au

Structured abstract

BACKGROUND

Nowadays, online mode of teaching is preferable over traditional instructor-led approach. This is because it attracts far distance students and thereby generating income for an institution on the one hand, and on the other hand, it responds to the needs of the students by enabling them to share resources, thereby reducing costs and saving time (see, e.g., Dewstow et al. 2000). But still, there are areas of study that require the traditional instructor-led mode of teaching (see e.g., Abbaszadeh et al. *2011*), where fieldwork is needed, e.g., in civil engineering surveying. The justification for actual field participation is that the student must have hands-on experience in operating surveying equipment, in addition to undertaking the actual tasks. The workshop session prior to fieldwork provides such understandings about the actual field task.

PURPOSE

The purpose of this study is to investigate how workshop develops surveying fieldwork skills for civil engineering students and improve their learning as field surveyors. Further, the study demonstrates a continuous process of improvement in practical surveying.

METHOD

Several workshop sessions were introduced prior to each field tasks in Civil Engineering Surveying unit at Curtin University. An anonymous questionnaire survey was conducted for all the students attending their last workshop. A structured questionnaire of 8 questions was prepared, reviewed by peers and validated by a group of previous students. The students were asked to put their agreement in a way similar to Curtin's eVALUate system. The survey data were analysed statistically using the confidence interval and percentage frequency methods to check the students' feedback in relation to learning outcomes and fieldwork skills development. The overall students' performances were also analysed to assess the impact of the workshops.

RESULTS

The highest student satisfaction (97%) shows that the workshop plays an important role in achieving overall learning outcomes, an argument that is also reflected in the exam performances. The majority of students who participated in the questionnaire could correlate theory to the fieldwork, gain surveying instrument knowledge, improve critical thinking skills and make them prepared for exam. The overall satisfaction of the students was strongly related to the five major attributes such as, correlate theory, instrument knowledge, critical thinking skills, fieldwork skills and exam preparation. The least agreement was found for handling of unseen problems and communication skills.

CONCLUSIONS

This study found that a workshop session prior to fieldwork in Civil Engineering Surveying provides better learning outcomes than a lecture session only. The overall satisfaction of the students about workshop was strongly correlated to five major attributes such as, correlate theory, instrument knowledge, critical thinking skills, fieldwork and exam preparation. The least agreement was found in communication skills which indicate that the workshop learning process needs further development for communication skills in field-based learning in Civil Engineering Surveying.

KEYWORDS

Workshop, Learning, Surveying, Fieldwork

Introduction

Collaborative learning environment exposes students to a variety of opportunities and knowledge, including creating awareness of global science and engineering trends, development of teamwork skills, fostering interest and motivation and peer interaction (e.g., Webb, 1989; Bourner and Flowers, 1997; Baroffio et al., 2006; Bartle et al., 2011; Vora and Markoczy, 2011; van den Bossche et al., 2006; Smith et al., 2005). A workshop-based learning is an important component of collaborative learning method in the development of such skills in engineering learning (Shelton and Hudspeth, 1989; Anwar et al., 2012). A well-educated engineering workforce is fundamental to innovation and entrepreneurship as it directly contributes to global economy, environment, security and health (Campbell et al., 2009). Hence, industries today seek engineering graduates who possess skills far beyond their classroom knowledge.

Workshop-based learning, especially in engineering, has proven on the one hand to improve the students' overall performance through conceptual understanding and close interaction with their tutors (e.g., Shelton and Hudspeth, 1989; Bourner and Flowers 1997; Anwar et al., 2012) while on the other hand, it enhances the quality of tutor's teaching skills (Baroffio et al, 2006; Pandachuck et al. 2004). For example, California State Polytechnic University, Pomona in USA has developed a two model academic excellence workshops in an Engineering Mechanics course (Shelton and Hudspeth, 1989) in order to increase the number of successful underrepresented minority engineering graduates. The result of the workshops proved very useful where underrepresented minorities scored on average one full letter grade above students who did not take part in the workshop program. Similarly, excellence workshop programs resulted in a strong retention tool in the Minority Engineering Program in the College of Engineering and Applied Sciences at Arizona State University (Adair et al., 2001). Additionally, the workshop program managed to serve as an assurance and recruit more students in engineering. An e-workshop pilot program launched in Riga Technical University, Riga, Latvia (Peteris et al., 2012), which was introduced in order to make students ready for practicals, resulted in good feedback from local and foreign students as well as interests from other universities in the city.

In a Civil Engineering course at Curtin University, a Civil Engineering Surveying unit is offered annually with one-hour lecture and a two-hour practical per week. Surveying is a basic requirement in a Civil Engineering profession, which is also a key to planning and initial set-up of an infrastructure project (e.g., Millis and Barber, 2004). The one-hour lecture is not sufficient for the students to grasp the vast subject of surveying including theoretical and practical knowledge, thus requiring more time to learn. In order to address this deficiency, a two-hour workshop session was introduced prior to their fieldwork from 2009 (see, e.g., Anwar et al., 2012). The two-hour workshop session provides students with more hands on knowledge on practical skills in surveying and thus, equips them for field practicals. Besides, it also provides a series of industry-based skills including team-work skills (see, e.g., Bartle et al., 2011), communication skills (e.g., Vora and Markozy, 2011), cross-cultural and multidisciplinary skills (e.g., Watson et al., 1993) and it also provides ample opportunity to prepare for their final exam. Practical workshops significantly develop team-work skills through student-centered learning activities. Group-based problem solving in workshop enable students to be more engaged and enhances their independent thinking skills, especially when they are required to tackle a given task in the field. As engineering problems are open eneded, groupwork helps the students to come up with the best possible solution and develop their teamwork skills, which is an essential criterion for a professional engineer.

In an earlier study, Anwar et al. (2012) mapped workshop learning with that of Curtin's graduate attributes and found that most of the learning outcomes from workshop addressed the Curtin graduate attributes. However, how the workshop enhances the development of fieldwork skills for civil engineering students and to improve their overall learning as field surveyor were not assessed. The purpose of this study, therefore, is to investigate how these workshops develop surveying fieldwork skills for civil engineering students, improve their learning outcomes and makes them ready for industry. Moreover, the study also demonstrates a process of improvement in learning surveying, especially in practical skills development.

Workshop learning process

The workshop was first introduced for civil engineering 2nd year students in 2009 at Curtin University. The workshops are organized to (i) provide an in-depth exposition of the unit materials, (ii) instruct step-by-step four practical sessions, and (iii) enhance students' critical thinking and computational skills through individual hands-on training. Two workshops per week are organized and each workshop consists of approximately 60 students. From an approximately 200 number of total students, each student is expected to attend 6 workshops for the entire semester where four workshops are tailored towards the development of practical skills while two are tailored towards exam preparations.

We point out that workshop learning is not similar to the traditional tutorial learning due to the fact that surveying engineering requires special training prior to their fieldwork activities. Workshop platform provides such a learning environment where students need to know about the surveying equipment (e.g., total stations, levels, GPS), whose handling cannot be demonstrated during the normal lectures or tutorials. The mode of conducting workshop was formulated as given below:

(a) One-to-one learning takes place in workshop. First, an overview of the materials covered in the lecture is presented, which is then followed by demonstrating the required computational skills to solve the real problems. Each student is asked to solve a given problem where the lecturer monitors their skills and helps them where necessary. One of the students is asked to demonstrate the solution on the white board. For more complicated problems, when it seems that none of the students can solve the problem successfully, the lecturer demonstrates the solution on the board.

(b) In the last 30 minutes of the workshop, the aims and practical aspects of next fieldwork are demonstrated including the handling of equipment. All parts of the equipment and their uses are demonstrated in a way that the individual student can use it independently. This demonstration and the knowledge gathered from (a) should be sufficient to carry out the field tasks and meet the required objectives. However, the last fieldwork is conducted as a practical examination.

(c) The last two workshops are done to revise the syllabus and prepare the students for final exam. Students are given model questions that assess their computational skills and abilities to think critically. The model questions cover the computational and necessary skills obtained in previous workshops and lectures and the activities carried out in the field. The students are given 1-hour to solve two problems individually. In the remaining hour, the solutions are discussed thereby providing the students an opportunity for their self-assessment.

After introducing workshop in 2009, it has been implemented each first semester to enhance the fieldwork skills in surveying engineering. The fieldworks are planned into four areas of evaluation in 4 different workshops (i.e., levelling profile, traversing, setting of horizontal curves, and designing of vertical curves). The fieldworks were designed in a way to provide scenarios reflecting tasks that could be reasonably expected out of an on-site junior civil engineer or a field surveyor. The workshops are therefore directly related to the fieldwork, the expectations are clearly enunciated, and the aim of the exercises is generally well understood.

Data collection

In order to investigate the field-skills development through workshop, an anonymous questionnaire survey was conducted for all the students undertaking the workshop in Civil

Engineering Surveying unit in 2012. To validate the survey, both face validation and content validation methods were adopted (OMB 2002). Face validity aimed at determining whether the questions addressing the workshop learning contributed towards the field-skills development and overall learning of surveying. The content validation aimed at assessing whether the survey fully captured and represented the concept that the workshop learning enhanced the achievement of necessary field skills. To address the face validation, a group of 8 students who undertook the unit in 2011 was selected and the draft questionnaire given to them to review. The students read the questions and put their agreement or disagreement in understanding the purpose of the survey, and also commented on whether the questions were clear or unambiguous. The suggestions obtained from the students were used to modify the questions until all the participants came to an agreement that the final modified questions were clear, unambiguous and captured the intended purpose. Content validation then followed by having the outcome of the face validation subjected to peer review by colleagues who were expert in the subject. The final questionnaire was then reviewed by the Dean of Teaching and Learning and then sent to the ethics committee for ethics approval. The approved set of questionnaire formed the survey instrument for this study and is shown in Table 1. These questionnaires were then distributed among the students in their last workshop. The last day of the workshop was chosen for survey in order to get maximum responses and also to get the wide range of learning experiences from all the workshops. The last workshop is dedicated towards the exam preparation and it is likely to have maximum presence of students. But there was also a chance of getting less number of students because of the due dates for other assignments. However, the survey was conducted anonymously and the feedback method was similar to Curtin's online unit eVALUate system such as, “Strongly Agree-SA”, “Agree-A”, “Strongly Disagree-SD”, “Disagree-DA and “Unable to Judge-UJ”. The data was then analysed statistically using confidence interval and percentage frequency method.

Table 1: Items in questionnaire survey

Survey items	**Questions**
1. Correlate theory	Did workshop help in correlating theory to the field work?
2. Instrument knowledge	Did workshops provide sufficient knowledge about the Surveying instruments?
3 Critical thinking skills	Did workshops enhance independent learning and critical thinking skills?
4. Fieldwork	Did the quality of teaching in the workshops help to achieve the learning outcomes for the fieldwork?
5. Handling unseen problems	With the aid of the workshops, could the students effectively learn to handle unseen problems, which occurred during the fieldwork?
6 Communication skills	Was it possible to achieve the communication skills during discussions in the workshops?
7. Exam preparation	Were the workshops useful in preparing the students for the Surveying exam?
8. Overall satisfaction	Overall, were the students satisfied with the workshops?

Method of analysis

Confidence interval estimation

When a portion of the student cohort takes part in the survey, it is necessary to validate whether the number represents the total enrolments. To analyse this, confidence interval estimation was done for the proportion, considering the total number of students enrolled to be finite. Confidence limit is a standard measure of accuracy of the results in a statistical analysis and is derived by first dividing the data into subsections and obtaining the mean. The confidence limit is then defined as a range of standard deviations from the mean (Huang et al., 2003). It is computed as (Heeringa et al. 2010):

$$p_{agree,N} = p_{agree,n} \pm Z\sqrt{\frac{p_{agree,n}(1-p_{agree,n})}{n}}\sqrt{\frac{N-n}{N-1}} \quad (1)$$

where $P_{agree,N}$ are the percentage of agreement for any attribute under consideration, n is the number of the students who responded to the questionnaire, N is the total number of the students enrolled in the unit, Z depends on the confidence level required, i.e., the value of Z becomes 1.96 for 95% confidence level. The confidence limits for the students enrolled is given by $P_{agree,N}$ .The confidence interval and survey data analysis procedures are discussed in detail in Heeringa et al. (2010).

Frequency Percentage Analysis

The data was analysed using the statistical frequency percentage method. In this approach, the total number of responses (Tr) per criteria are identified. Within each criteria, the total number of responses, i.e., SA, A, SD, D and UJ are then divided by the total number of responses per criteria and multiplied by 100 to give the equivalent percentages. For the SA criteria for example, the process of creating a percentage frequency distribution involves first identifying the total number of observations to be represented (Tr) then counting the total number of observations within each data point or grouping of data points (TSA) and then dividing by the total number of observations (Tr) and multiplying by 100 (e.g., TSA/Tr x 100). Details on the method are presented, e.g., in Heiman (2011).

Results and discussion

Confidence limit

A total number of 67 students, out of 191 enrolled in 2012, responded to this survey anonymously. The reason of relatively low response was because of low attendance in the last workshops held in the last two weeks of the semester where the students are usually busy with other assignments. The sample of students who took part in the survey (n=67) was tested against the total number of enrolled students (N=191) using the confidence limit procedure (Heeringa et al., 2010). In this study, the confidence limit analysis was done for all the survey items and is presented in Table 2. The six survey items “correlate theory”, “instrument knowledge”, “critical thinking skills”, “fieldwork”, “exam preparation” and “overall satisfaction” showed lower confidence limit of > 0.8. The results in terms of the confidence limit presented in Table 2 shows a lower confidence limit higher than 0.9 for three main attributes, correlate theory, exam preparation and overall satisfaction, and a lower limit higher than 0.8 for the remaining three attributes: Instrument knowledge, critical thinking and fieldwork. The sample can hence be said to represent the total number of students enrolled when agreement to any of the six major attributes is discussed. Apart from the above six attributes, two other attributes handle unseen problems and communication skills gave a lower confidence limit of 0.582 and 0.598 respectively, since the agreement for these two attributes was poor and lied around 67.2 and 68.7%. The confidence limit results indicate that the 67 sample of students used in this study was representative of the whole number.

Table 2: The confidence limits for the questionnaire survey items for the students enrolled (N), N=191 based on the sample (n), n=67

Questionnaire survey items (e.g. attributes)	% agreement	Lower confidence limit	Upper confidence limit
1. Correlate theory	97.0	0.938	1.0

2. Instrument knowledge	96.6	0.837	0.954
3. Critical thinking skills	91.1	0.856	0.965
4. Fieldwork	91.1	0.856	0.965
5. Handle unseen problems	67.2	0.582	0.761
6. Communication skills	68.7	0.598	0.775
7. Exam preparation	98.5	0.962	1.0
8. Overall satisfaction	97.0	0.938	1.0

Percentage frequency analysis

The frequency percentile method was applied for all the items used in the survey and presented in Table 2 (see, e.g., Heiman, 2011 for discussions on the procedure). The results revealed a strong agreement of students that the workshop enhanced their 'correlate theory (97%)', 'instrument knowledge (89.6%)', 'critical thinking skills (91.1%), fieldwork skills (91.1%) and exam preparation (98.5%). Several methods could be adopted in order to achieve the aims of the "critical thinking" skills in higher studies (see, e.g., Snyder and Snyder 2008). The present study emphasises on assessing the workshop learning approach to see how it contributed towards the development of field skills and critical thinking skills in surveying. The questionnaire survey results show that 91.1% of the sampled students agreed the workshops helped them achieve critical thinking and field skills. These indicate that the students' critical thinking skills can be achieved not only through teaching but also through other development methods (Jawarneh et al., 2008; Khasawneh, 2004) such as, workshop. It also shows that the workshop is an appropriate platform to develop field skills. Moreover, workshop is also a learning platform for exam preparation. The results revealed that exam preparation had the highest agreement (98.5%) in students' survey. The least agreement was found for "communication skills" and "handling unseen problems" as 68.7% and 67.2% respectively. This relatively low agreement indicates that the workshop learning process needs further development for communication skills and problem solving skills. The students usually put their agreement on the item "communication" based on the paper-based feedback that they receive in their written report. This is a university-wide concern of getting lower agreement on feedback item. Getting less agreement in handling unseen problem in surveying fieldwork is also a matter of concern and needs further investigation.

Students' performances

Besides the questionnaires administered during the last workshop, we further investigated how the workshop learning contributed towards achieving fieldwork skills and learning surveying. The overall student performances were checked for the period of 2009-13. Figure 1 shows the effect of workshops on the overall performances considering fieldwork marks, exam marks and total marks respectively. The overall performance may vary with respect to the class sizes. The workshop learning and teaching material in 2009 was not fully developed as the workshop had just been introduced in 2009. Moreover, multiple tutors marked the field practical reports, which provided high marks in this component in 2009. These findings were taken into account and the workshop learning platform were redesigned by putting appropriate learning resources and providing useful feedback with the objective to achieve better performance in fieldwork and learning experiences. These are clearly reflected in the results of 2010-2013 (see Figure 1). Again, handling unseen problems in the field scored low percentage (i.e., 68.7%) which was taken into account in 2013 workshop and a special attention was given to this item. Probable unseen problems that might occur in fieldwork survey were discussed more in 2013 workshop. Students were more equipped for any unseen problems in 2013 which is clearly reflected in the students' mark of field practical component in 2013. It increased from 74% (2012) to 91% (2013) which shows direct impact of workshop in improving student learning. The overall students' performances were found slightly varying in different years because of the number of enrolled students. As the number of students in this unit is continuously increasing since 2009, lecturers face more challenges in assessing the field practical reports. It is critical to consider whether group submission or individual submission of a group work can provide sufficient learning outcomes addressing the graduate attributes. However, this issue is currently under investigation and will be reported in our forthcoming paper.

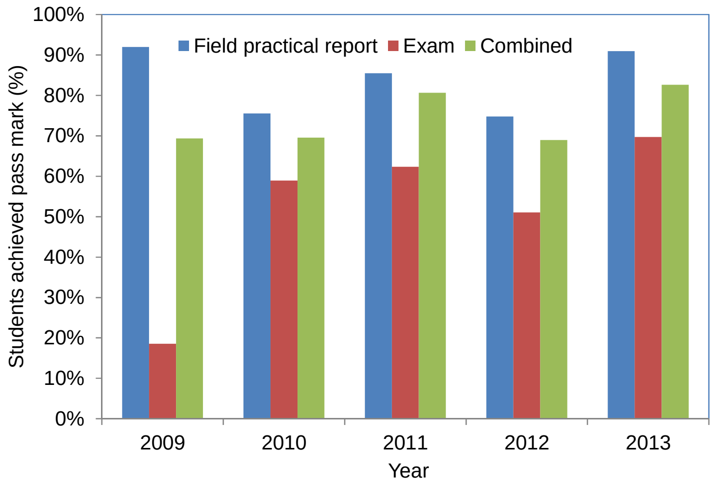

Figure 1 Students' performances in civil engineering surveying unit for 2009-2012

Conclusions

The effect of workshop in learning Civil Engineering Surveying and developing fieldwork skills are investigated in this study. Results revealed that the workshop session prior to fieldwork provides better learning outcomes than a lecture session only. This is evident from the questionnaire data analysis as well as the student performances in practical and exam results. The overall satisfaction of the students about workshop was strongly correlated to five major attributes such as, correlate theory, instrument knowledge, critical thinking skills, fieldwork skills and exam preparation. The least agreement was found in communication skills and handling unseen problems, which indicate that it needs further development for these items. Handling unseen problems was improved putting special care for this item in the workshop prior to fieldwork in the following year. But there is a need to embed this item in course curricula so that the students can develop this skill for any unseen issues in a field-based engineering problem. However, this item is less investigated in the literatures and needs to be explored further to improve workshop learning process.

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