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Mapping workshop learning to graduate attributes for Civil Engineering Surveying

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BACKGROUND

One of the core units for 2nd year civil engineering students at Curtin University is Civil Engineering Methods 267 (Civil Engineering Surveying), where the students are currently expected to attend lectures and field practicals. These lectures and practicals are aimed at obtaining sufficient learning outcomes that address Curtin's graduate attributes. Previously, it was only one-hour lecture per week which did not provide required learning outcomes because of the practical nature of the unit. Realizing this, a two-hour workshop per week was introduced in 2009 to provide field training and computational skills. But until now, no study has been carried out to assess whether the workshop learning addresses the graduate attributes.

PURPOSE

The purpose of the current study is to focus on the workshop learning for Civil Engineering Surveying and to map them with the Curtin's graduate attributes in order to provide an indication for further improvement in the teaching-learning method for this unit.

METHOD

Structured questionnaires of 11 questions that describe the attributes were prepared, reviewed by colleagues and validated by a group of students who did the unit previously. The survey was conducted anonymously in the last workshop and the feedback was obtained in the form: "Strongly Agree-SA", "Agree-A", "Strongly Disagree-SD", "Disagree-DA and "Unable to Judge-UJ". A total number of 67 students responded to this survey and the data was analysed statistically. The data of students' performances (2009-2012) was further considered in mapping the attributes.

RESULTS

Results show that three graduate attributes ("discipline knowledge", "thinking skills" and "information skills") were mapped well with that of workshop attributes such as 'correlate theory (97%)', 'instrument knowledge (89.6%)', and 'critical thinking skills (91.1%)' respectively. Graduate and workshop attribute "communication skills" was found to be 68.7% of mapping. This relatively low agreement indicates that the workshop learning process needs further improvement on communication skills.

CONCLUSIONS

The results revealed that the workshop may be used as a good learning platform for Civil Engineering Surveying class. The workshop attributes were found to be well mapped with most of the Curtin graduate attributes.

KEYWORDS

Graduate attributes; Workshops; Learning; Mapping

1. Introduction

Curriculum and cultural reform is an important aspect in engineering education in many countries including Australia. Engineering skills can directly contribute to the global economy, environment, security and health (Campbell et al., 2009). Industries demand that the graduates are work-ready the day they leave university. They seek engineers with abilities and attributes that are beyond their first discipline knowledge. These include deep technical understandings which enable engineers to work effectively in a business environment: communication skills; team working skills; and business awareness of the implications of engineering decisions and investments (Engineers Australia, 2006). Graduate attributes are the orientating statements of outcome-based education which are used to inform curriculum design and engagement with teaching and learning in a university setting (Barrie, 2007; Barrie, 2009).

Over the past decade, engineering schools of Australian universities have been committed to being innovative and responsive to students' development and industrial needs, while at the same time meeting the requirements of the professional accreditation bodies. However, it still remains a challenge to integrate the professional developments of the students with that of outcome-based education. The reason for this is because of the traditional thinking about engineering curricula, which holds onto past messages (Rover, 2008). Felder and Brent (2003) indicated that equipping students with necessary skills (e.g. graduate attributes) is much harder than determining whether or not they have these skills. Many researchers have identified that much of the students' graduate attributes learning occurs incidentally, accidentally, or outside of formal classroom settings (Kuh, 1995; Treleaven and Voola, 2008; Walther and Radcliffe, 2007).

Curtin University in Australia is committed to producing graduates who demonstrate the following graduate attributes: (i) applying discipline knowledge, (ii) thinking skills, (iii) information skills, (iv) communication skills, (v) technology skills, (vi) learning how to learn, (vii) international perspective, (viii) cultural understanding and (ix) professional skills (Graduate Attributes Policy, 2006). Among the graduate attributes above, critical thinking is the most common in several universities. This is because higher institutions aspire to produce graduates who are critical thinkers (Tek-Yew 2012). On thinking skills, for example, Snyder and Snyder (2008) observed that students needed to be taught the process of critical thinking to be able to think critically, and added that critical thinking was a process of education, training and practice (Tek-Yew 2012). Jawarneh et al. (2008) and Khasawneh (2004) among others conducted analysis on how students' critical thinking skills could be developed using different teaching methodology. Their results pointed towards the use of different methodology to achieve the outcome of the critical thinking attribute (Tek-Yew 2012).

At Curtin University, students are presented with varieties of teaching, learning and assessment instruments to enable them to develop and demonstrate these attributes. The unit learning outcomes are shown in the unit outline addressing the specific graduate attributes. The unit coordinator designs the unit delivery in such a way that it addresses as many attributes as possible. However, it becomes difficult to address all the attributes when the class sizes becomes large (>200) especially in terms of assessment experiences. One of the core units for 2nd year Civil Engineering students at Curtin University is Civil Engineering Methods 267 (CEM267: Civil Engineering Surveying, with enrolments $\approx$ 200). The students of this unit are expected to attend lectures and field practical Surveying. These lectures and practicals are aimed at four main learning outcomes: (i) understand Civil Engineering drawings appropriately for construction purposes, (ii) apply the theory and practice of surveying instruments for Civil Engineering and construction projects, (iii) explain and apply related calculations and surveying techniques in Civil Engineering and construction projects, and (iv) describe the theory and practice of using surveying instruments as applied to Civil Engineering and construction projects.

In 2008, it was realised that one-hour lecture per week was not sufficient to gain the required learning outcomes as specified by Curtin's graduate attributes. Lecture only unit delivery does not provide adequate skills development on computation and instrumentation handling. To overcome these shortcomings, a two-hour workshop per week was introduced in 2009 to provide hands-on training on surveying instruments and its application to real-life problems as suggested, e.g., by Jawarneh et al. (2008) and Khasawneh (2004). Though it was considered that workshops would provide more learning outcomes addressing graduate attributes, until now however, there has been no study that mapped the workshop learning with that of graduate attributes. This study focuses on this issue.

2. Workshop Learning

This study is part of a faculty funded research project on the mode of assessment for a large group of students in Civil Engineering Surveying. The Civil Engineering Surveying students have four assessed practicals; two of which are individual-based submission while two others are group-based submission. The workshops (2hr duration) are aimed at (i) providing an in-depth exposition of the unit materials, (ii) instructing step-by-step four practical sessions, and (iii) enhancing 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 total number of students, each student is expected to attend 6 workshops for the entire semester; where four workshops are tailored towards the practicals while two are tailored towards exam preparations.

To achieve the aims of the workshop listed above, the following tasks and activities are carried out in the workshop (examples are given for illustration):

a) Students are provided one-to-one understandings of the materials learnt in 1-hour lecture. 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 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 white board. For more complicated problems, when it seems that none of the students could solve the problem successfully, the lecturer demonstrates the solution on the board.

b) In last 30 minutes of the workshop, students are introduced to the aims and practical aspects of the fieldwork for that particular week. The practicals are designed such that the students are able to apply their knowledge gathered from (a) to complete their practical tasks. For example, if the practical task requires designing a cycling path, they are expected to know how longitudinal heights and cross-sectional profiles are measured, and how these heights are used to compute the vertical profiles and volumes from cut and fill. The computational skills obtained in (a) are used to employ critical thinking while the student undertakes the design given in the problem.

c) In order to demonstrate the computational and critical thinking skills obtained in (a) and (b), the last fieldwork is conducted as a practical examination. However, one of the objectives of fieldwork is also to develop teamwork skills as Engineers Australia's Graduate Attributes emphasize the ability of graduate engineers to work in high performance teams. Students carry out the tasks in a team but make their calculations individually. From the assessment point of view, verbal and written feedbacks are provided for both individual and teamwork skills.

d) The last two workshops are done to revise the syllabus and prepare the students for exams. 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 field practicals. The students are given 1-hour to solve two problems

individually. In the remaining hour, the solutions are discussed and thus it provides the opportunity for self-assessment of the students.

The workshops are undertaken basically for four different field practicals and preparing the students for the exams by demonstrating necessary skills that is reasonably expected out of an on-site junior civil engineer. The workshops are, therefore, directly related to the fieldwork, the expectations are clearly enunciated, and the aims of the exercises are generally well understood.

3. Data Collection and Analysis

In order to assess whether workshop learning mapped with Curtin's graduate attributes (Table 1), a structured questionnaire was prepared (Table 2) which can be easily mapped with Curtin's graduate attributes listed in Table 1. 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 achieving the graduate attributes. The content validation aimed at assessing whether the survey fully captured and represented the concept that the workshop learning enhanced the achievement of the graduate outcomes. To address the face validation, a group of 8 students who undertook the unit in the previous year was selected and the questionnaire was administered to them. Their task was to read the questions and put their agreement or disagreement in understanding the purpose of the survey, and also 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 for peer review by colleagues who were experts in the subject. The final questionnaire was then passed to the Dean of Teaching and Learning for further refinement before being sent to the ethics committee for their final approval. The approved set of questionnaire formed the survey instrument for this study. These questionnaires were then distributed among the students in their last workshop. The last day of the workshop was chosen for survey because of getting feedback from the whole range of workshop learning. 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 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 (e.g. TSA/Tr) and multiplied by 100 to provide the equivalent percentages. Details of the method are presented, e.g., in Heiman (2011).

4. Results and Discussion

A total number of 67 students 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). 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). In this study, the confidence limit analysis was done for all the survey items given in Table 2. The five survey items "Correlate theory", "Critical thinking skills", "Field work", "Exam preparation" and "Overall satisfaction" showed lower confidence limit of > 0.8. The remaining survey items had lower confidence limits of values greater than 0.7, which indicate that the 67 sample of students used in this study was representative of the whole number (e.g., Heeringa et al., 2010).

Table 1: Mapping workshop's learning to the Curtin's graduate attributes (Source: Curtin University's webpage)

Item No.	Survey Items	Curtin Graduate Attributes
1	Correlate theory	
2	Instrument knowledge	
3	Critical thinking skills	
4	Field work	
5	Self assessment	
6	Handle unseen problems	
7	Communication skills	
8	Individual assignments	
9	Group assignments	
10	Exam preparation	

Curtin Graduate Attributes					
	Apply discipline knowledge		Thinking skills (use analytical skills to solve problems)		Information skills (confidence to investigate new ideas)
	Communication skills		Technology skills		Learning how to learn (apply principles learnt to new situations) (confidence to tackle unfamiliar problems)
	International Perspective (value the perspective of others)		Cultural understanding (value the perspective of others)		Professional skills (work independent and as a team) (plan own work)

Table 2: Questions used in the survey

Survey item	Description of question	Percentage agreement
Correlate theory	Did workshop help in correlating theory to the field work?	97.0%
Instrument knowledge	Did workshops provide sufficient knowledge about the Surveying instruments?	89.6%
Critical thinking skills	Did workshops enhance student's independent learning and critical thinking skills?	91.1%
Field work	Did the quality of teaching in the workshops help to achieve the learning outcomes for the field work?	91.1%
Self assessment	Were discussions during the workshops appropriate to assess the student's knowledge and understanding of the field work?	89.6%
Handle unseen problems	With the aid of the workshops, could the students effectively learn to handle unseen problems which occurred during the field work?	67.2%
Communication skills	Was it possible to achieve the communication skills during discussions in the workshops?	68.7%
Individual assignments	Did the workshops help the students in their individual mode of assignments?	89.6%
Group assignments	Did the workshops help the students in their group mode of assignments?	82.1%
Exam preparation	Were the workshops useful in preparing the students for the Surveying exam?	98.5%
Overall satisfied	Overall, were the students satisfied with the workshops?	97.0%

The frequency percentile method were applied for all the items used in the survey and presented in Figure 1 (see e.g., Heiman, 2011 for discussions on the procedure). The results revealed that the graduate attributes of "discipline knowledge", "thinking skills" and "information skills" were achieved well, with a strong agreement of students obtained for the assessed workshop attributes; 'correlate theory (97%)', 'instrument knowledge (89.6%)', and 'critical thinking skills (91.1%)'. As argued by Tek-Yew (2012), several methods could be adopted in order to achieve the aims of the "critical thinking" attribute. This study emphasises on assessing the workshop learning approach to see how it contributed towards the development of the "critical thinking" attribute. The survey results indicate that 91.1% of the sampled students agreed that the workshops helped them achieve critical thinking 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). Curtin's graduate attribute of "learning how to learn (apply principle learnt to new situation; confidence to tackle unfamiliar problems)" were mapped using the survey items: 'self-assessment', 'help in field-work', 'handling unseen problems during the field-work' and

'exam preparation' respectively. The agreements of mappings for these attributes were found 89.6%, 91.1%, 67.2% and 98.5% respectively.

Curtin's graduate attribute "communication skills" was mapped to workshop's survey item 'communication skills' and found 68.7% of agreement. This relatively low agreement indicates that the workshop learning process needs further development for communication skills. The graduate attributes on "international perspective" and "cultural understanding" were reflected in the students' agreement for 'working in groups', where 82.1% of students agreed that the workshops were helpful for group work in practical survey. The graduate attribute "professional skills" was mapped to the survey item 'individual submission' and found 89.6% of students' agreement. This indicates that the workshop is a good learning platform for becoming an independent learner for professional development.

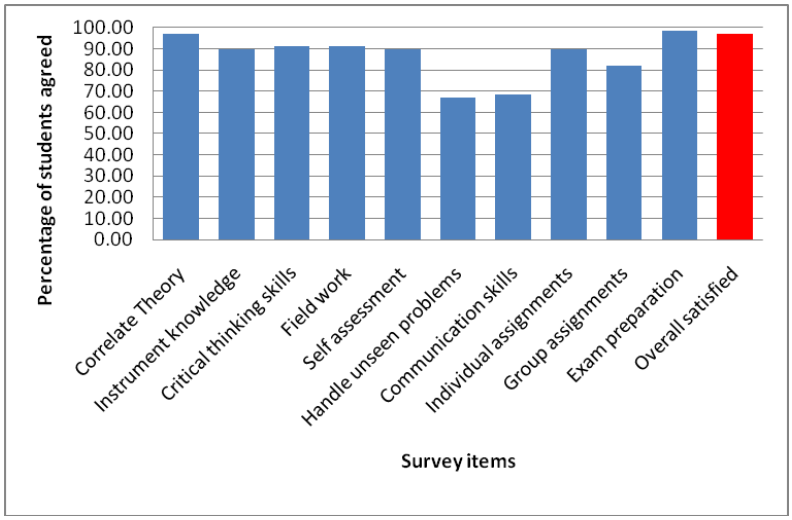

Figure1: Percentage agreement of students on various survey items

In order to further investigate how the workshop learning contributed towards achieving the graduate attributes, students performances were checked for 2009-2012. Figure 2 shows the effect of workshops on overall performances considering fieldwork marks, final exam marks and combined marks for the period 2009-2012. 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. Moreover, mutiple tutors marked the field practical reports, which provided high marks in this component in 2009. But on the other hand, the performance in the exam part (60% of the unit) clearly revealed that the student learning did not map well with graduate attributes as the pass rate in the exam component is less than 20%. Overall, the pass rate was about 69% because of high marks obtained in the practical reports. 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 the graduate attributes. These are clearly reflected in the results of 2010-2012 where the results show slightly lower fieldwork achievements. The students' performance in the exam component (closed book exam) is increased by 3 times in 2010 because of the implementation of new workshop learning platform. The final examination results show a significant improvement due to the fact that the exams taken from 2010 were re-modelled on the areas covered in the lectures, but more specifically covered in workshops and fieldworks. The overall students' performences were also found to slightly vary in different years becuase of the number of enroled students. As the number of students in this unit is continuosly 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 outcmoes addressing the graduate attributes. However, this issue will be reported in our forthcoming paper.

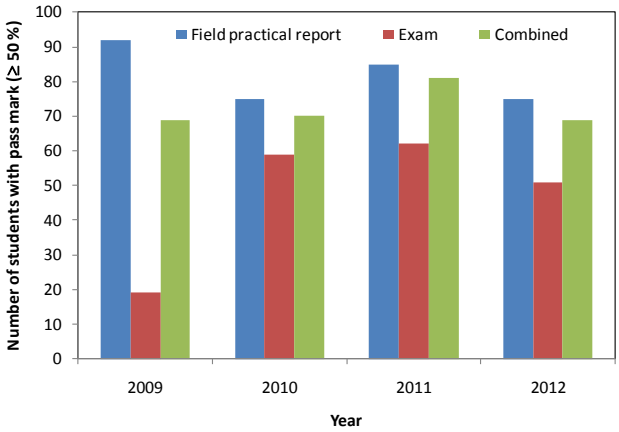

Figure 2 Students performances in Civil Engineering Surveying for 2009-2012.

5. Conclusion

The results revealed that the workshop may be used as a good learning platform for Civil Engineering Surveying class. The workshop attributes were found to be well mapped with most of the Curtin's graduate attributes. The most agreement was obtained for the first three graduate attributes; "discipline knowledge", "thinking skills" and "information skills". A relative low agreement was found for the attributes of "communication skills" and "confidence to tackle unfamiliar problems". Student's unhappiness with communication skills was due to the feeling that they were not getting feedback on their submitted assignments. This is an area of concern since a low rate of fieldwork papers collection by the students was noticed. Only about 40% of fieldwork papers were collected by the students and hence it is enhancing lower agreement on communication skills. However, the evaluation of students' submissions provides staff with major feedbacks on the areas that need students' improvements. These feedbacks are communicated in the subsequent workshops. But most of the students have the understandings that the feedbacks are only written comments given on their submission. However, these aspects are needed to explore further for improving the workshop learning mechanisms and addressing the graduate attributes.

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