Blended learning in higher education: Current and future challenges in surveying education

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The development of a blended learning approach to enhance surveying education is discussed. The need for this learning strategy is first investigated based on a major review of the surveying course, including analysis of its content, benchmarking with key national and international universities, and surveys of key stakeholders. Appropriate blended learning methods and tools that couple learning theory principles and developing technical skills are discussed including using learning management systems, flip teaching, collaborative learning, simulation based e-learning, and peer assessment. Two blended-learning tools developed for surveying units are presented as examples. The first is an online interactive virtual simulation tool for levelling, one of the key tasks in surveying. The second is an e-assessment digital marking, moderation and feedback module. Surveys of students showed that they found the interactive simulation tool contributes to improving their understanding of required tasks. Students also found the e-assessment tool helpful in improving their performance and in helping them to focus on the objectives of each activity. In addition, the use of peer e-assessment to improve student learning and as a diagnostic tool for tutors is demonstrated. The paper concludes with a discussion on developing generic skills through authentic learning in surveying education.

Introduction

Learning is an inherently social process, where different strategies for effective learning can be implemented (Strobl, 2007). The use of new technologies in teaching and learning, e.g. e-learning, can assist in both the enhancement of traditional teaching methods and the development of students' technical skills. At present, there are several e-learning technologies available (Garrison, 2011). Many of these address mobility of student learning, which enables students to learn anywhere, anytime, and with various devices (Herrington et al. 2012). These include learning management systems providing a virtual platform for students to access teaching resources and interact with peers and other students, web-based flexible learning environments, and media to encourage collaborative learning among students. In regard to developing technological skills, a wide range of technologies can be used to assist in training students. These can range from videos for demonstration, recording and reflective analysis purpose to simulation-based e-learning (SIMBEL) systems.

The rapid technology change can adversely result in a shift from higher education towards training (Burtch, 2005), i.e. while trying to keep up with new technology, more focus may be put on skill development rather than on learning theoretical principles. Therefore, a balance of the two components should always be maintained. To face this challenge, a blended learning approach, where learning education combines face to face classroom methods with computer-mediated activities (Strauss, 2012), can be used to combine technology with pedagogical principles for the benefit of student learning (Garrison & Kanuka, 2004; Hoic-Bozic et al. 2009).

This paper is an extension of El-Mowafy et al. (2013) and presents a blended teaching approach using surveying education as an example. In addition to classroom learning, it includes online learning and mobile learning. Blended learning encourages the gaining of knowledge coupled with traditional information-gained skills-development learning (authentic learning). Figure 1 shows an illustration of the components of blended learning and its target outcomes. Classroom learning is still considered the largest learning component.

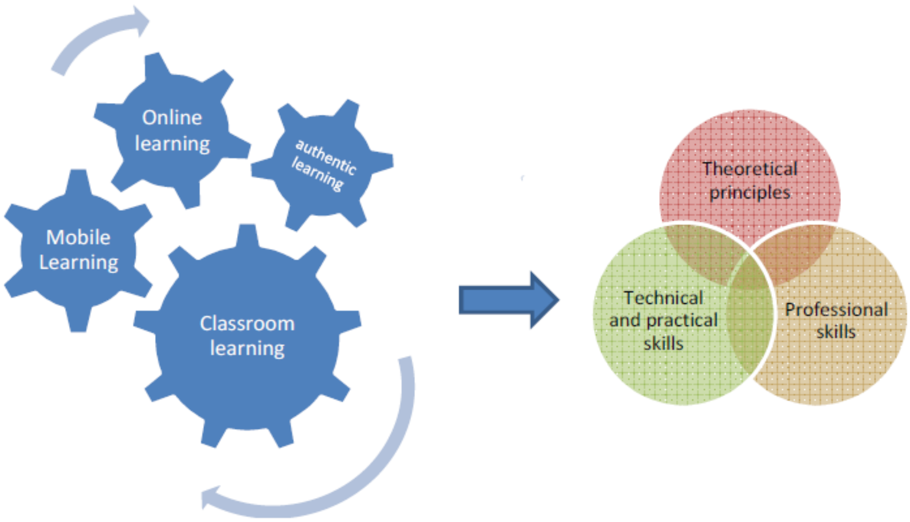

Figure 1: Blended learning methodology

The paper discusses how blended learning methods have been applied to face some of the current and future challenges in the surveying education field. Firstly, the need for a blended learning approach in addressing rapid technology change in higher education is discussed, which came as a result of a recent review of the Bachelor of Surveying at Curtin University, Perth, Australia. This survey was originally performed to gauge learning and teaching efficiency, and evaluate content and use of new technologies in teaching. While the former has to satisfy the needs of stakeholders (e.g. the surveying profession), the latter has to address the problems of teaching a content-rich syllabus with limited resources as found in surveying education. The key outcomes and observations of this course survey are presented to show the need for blended learning. Next, the paper discusses some blended learning methods and tools. Examples are given on efficient inclusion of some of these methods and tools in surveying education, such as the simulation-based e-learning (SIMBEL), the use of e-assessment as a marking, moderation and feedback tool, and peer assessment. The paper concludes by providing an example on how authentic learning in surveying is used to develop generic practical skills. While the focus of this paper is on education in surveying, the authors believe that the methods outlined can be useful to other disciplines in applied sciences, such as engineering, agriculture, mining and physical education.

Why a blended learning strategy in surveying education

Surveying is the science of determining three-dimensional positions on or close to the Earth's surface. Education in surveying has to cover a broad range of fundamental topics in mathematics, physics, engineering and law (e.g. Greenfeld, 2011). Apart from a good understanding of these foundations, a surveyor also has to be proficient in the collection, processing, analysing and presentation of spatial data. Traditionally, the use of technology has always played an important part in surveying and therefore surveying education. It is set to play an ever more important part in surveying education in the future, given the expanding use of satellite-based measurements, laser scanner devices, online data transfer, etc. In such an environment, students need to have a solid understanding of the theoretical principles underpinning surveying as well as developing the technological skills that rely heavily on authentic practical learning (e.g. work integrated learning). This practical skill development places a very high demand on tutors (e.g. one-to-one training), and resources such as survey instruments and finance (e.g. highly specialised and costly instruments). Therefore, surveying teaching and learning strategies have to adopt more suitable methods to both enhance student learning and satisfy the needs of the industry and the profession.

Facing challenges through periodic course review

In the light of continuous changes in technology, teaching methods and required skills of study, there is a continuous need for a course to be evaluated in areas such as:

- completeness and appropriateness of content
- course structure (e.g. topics build up on previous ones)
- skills required (e.g. industry demand)
- teaching and assessment methods (e.g. classroom versus authentic learning)
- competitiveness with other courses and/or universities (e.g. unique elements).

These aspects are usually addressed through major course reviews, which should be done rather frequently (e.g. every five years) in areas of rapid changes. While each course review has its own unique aspects, reviews should consider the six main steps as illustrated in Figure 2.

In surveying, the main aspects illustrated in Figure 2 have recently been addressed during a major course review of the Bachelor of Surveying offered by the Department of Spatial Sciences at Curtin University, Perth, Australia. It was concluded that a blended learning strategy was the appropriate approach to achieve the program goals of enhancing the learning process, developing generic and technical skills, and rectifying course structure problems identified. The main points from the review that supported these conclusions were:

Step 1: Analysing existing course

Analysis of the existing course was done internally, involving mostly course team members within the department. Based on past experiences within the course, strengths and weaknesses were identified. Key outcomes regarding the teaching aspects identified a good balance between theory and practical exercises together with work placements as a major strength. Weaknesses identified were in part related to inconsistent connection between content, but mostly identified a rather low focus on generic skills such as problem solving, communication and project management skills. The latter are recognised as important skills in the 21st century (e.g. Griffin et al., 2012).

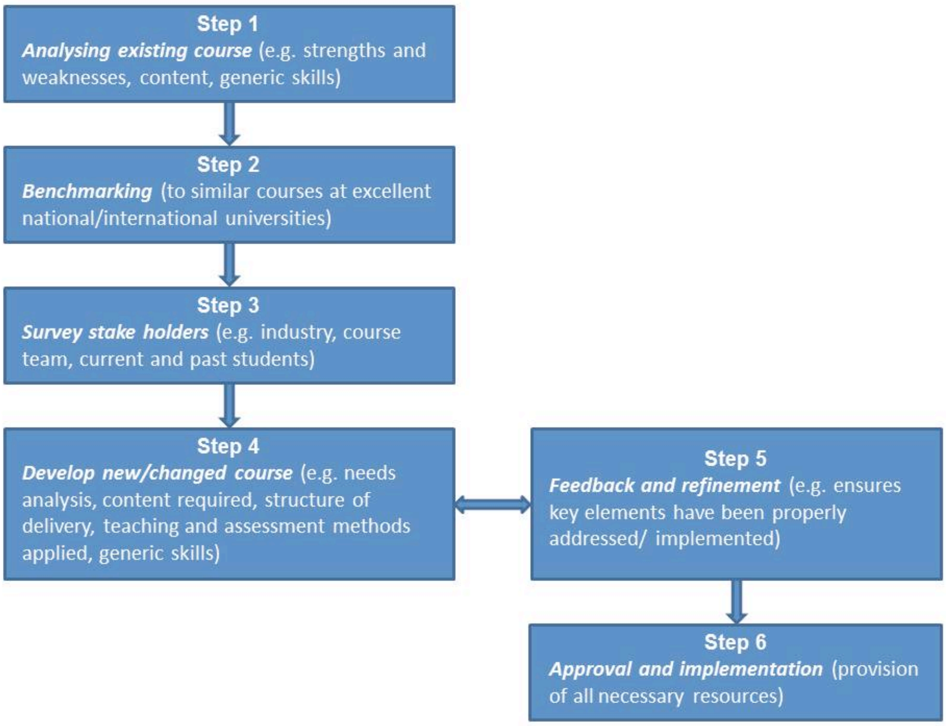

Figure 2: General layout of a course review

Step 2: Benchmarking

Benchmarking with eight key national/international universities offering similar courses was done in order to assess the current course content and to identify any major deficiencies. This information is important for future strategic decisions such as focusing on market niches and/or addressing shortcomings in content and the distribution of teaching resources to cover content. It was evident from this exercise that the current course structure and content are closely aligned to the surveying courses offered by the eight benchmarking universities chosen.

Step 3: Survey stakeholders

Important information was sourced through various surveys of key stake holders such as industry employers, professional organisations and current students and staff at the university. Assisted by the Surveying and Spatial Science Institute (SSSI) a series of industry focus groups were held to discuss the course in general and provide specific feedback on current content, student graduate abilities and future surveying education directions. Based on the *graduate employability indicators* proposed by Oliver et al. (2010) and Oliver (2011) a questionnaire was sent out to all major employers and licensed surveyors in the state in order to gauge employer perceptions. Overall, the outcomes of the focus groups and the questionnaire responses agreed that graduates have a knowledge level appropriate to the industries' needs, show great enthusiasm for their work and have a high willingness to learn. On the downside, the focus groups and surveys identified a lack in some generic skills such as team work, critical thinking, communication, the ability to solve complex problems, a poor perception of professional worth and the *lack of ability to integrate new technologies* into current surveying practice. Interestingly, the same lack of generic skills was identified by the internal assessment of the existing course.

The perceptions of the 11 course team members showed in general similar trends as the industry insights. As the analysis and benchmarking of the existing course resulted in no major knowledge gaps in this course review, the main focus was on assurance that knowledge is adequately covered. Current students and recent graduates were also asked to respond to questionnaires relating to their perception of the course and preparedness for the surveying industry. A key outcome was a confirmation that the inclusion of many practical survey exercises (about 25% of the course has a practical engagement) largely contributed to a high student satisfaction. In other words, students would appear to appreciate authentic or work-integrated learning.

Step 4: Develop new/changed course

Based on outcomes of the various surveys, a new design for the course was developed. Changes to the existing course, focusing mostly on a blended learning approach, such as the improvement on generic skills of new cutting edge surveying technologies (e.g. satellite positioning and laser scanning), enhanced skill-development activities, mobile learning, and a balanced distribution of content across units, have been used to further strengthen the authentic learning components of the course. Some of the units within the course have also been redesigned and re-organised in order to allow a scaffolded assessment approach, and to blend the practical assessment with formative assessment. This approach was adopted to reinforce development of generic and technical skills, as it appears that student satisfaction is closely related to authentic surveying fieldwork tasks.

Furthermore, all changes made were scrutinised from a holistic view of the total course, to ensure enhancement of student success and satisfaction. In addition, the definition of the new course structure included information and implementation of the 'surveying body of knowledge' (e.g. Greenfeld, 2008). Problems raised by the industry regarding a lack of generic skills have been addressed through curriculum mapping that ensured the syllabi of all units was updated and assessments were matched to meet the University's core graduate attributes (e.g. generic skills).

Step 5: Feedback and refinement

The new course structure was discussed with all stakeholders to gain feedback on the intended changes to the course. Refinement of the new course structure was mostly done internally. This evolved around the optimal inclusion of new units, content and scaffolded assessments across units. Feedback from industry and students showed their satisfaction with the proposed changes.

Step 6: Approval and implementation

After gaining the satisfaction of all stake holders, approval for the necessary course changes was obtained by the University. Once approved, all changes were made in the implementation phase. This required the provision of all the necessary resources.

Blended learning methods and tools

Surveying education consists of face to face classroom teaching to learn theoretical principles, and authentic learning (e.g. practical exercises) to develop technical skills. Both areas of teaching can benefit from e-learning technologies, ultimately leading to a blended learning approach in surveying education. This approach can also be used to address the problem of how to *better* engage students in the learning process. This paper considered a blended learning approach that combines traditional face-to-face classroom teaching methods with e-learning. In effect, this means that learning is becoming ever more focused around the use of computers and modern communications. While the paper provides specific examples on the use of new technologies in surveying education in the following section, this section will provide some more general considerations that are already partly in place, or may become the norm in the future.

Central to e-learning approaches are learning management systems (LMS), such as *Blackboard Academic Suite*, that administer web-based learning activities (Garrison & Vaughan, 2008). Already common in many higher education institutions LMS are used to assist in the delivery and management of learning-related material, such as course notes, lecture recordings, e-assessments, and discussion forums, etc. Like other web-based technologies, the advantage of LMS is their continuous availability from any location given access to the Internet. LMS can be used for both the delivery of fully online courses as well as the enhancement of traditional face to face classroom teaching.

Commonly based on written material and videos is the concept of *flip teaching*. This approach of blended learning replaces the traditional face to face classroom lectures. It is a form of active and collaborative learning (Silberman, 1996; Prince, 2004). In flipped teaching, students are provided with learning material (e.g. course notes and videos of lectures) to prepare themselves for the classroom and/or practical activities. Instead of traditional passive teaching in the classroom, teachers can focus more on specific questions and/or problems raised by tutors and students that promote or reinforce the targeted subjects' outcomes. The concept of flip teaching has been trialled successfully in some surveying units (e.g. GPS Surveying). Here students are actively involved in addressing questions, debating and finding solutions to problems that address the desired learning outcomes.

According to the *Assessment and teaching of 21st century skills* (Griffin, McGaw & Care, 2012), *collaborative learning* is an important skill in the 21st century. It directly addresses some of the generic skills such as problem solving, critical thinking and communication. While collaborative learning is not a new concept, it recently gained a new dimension with computer-assisted methodologies such as the use of Web 2.0 technology, LMS, and social media. While encouraging teamwork in collaborative learning students benefit from an active exchange of knowledge and ideas as well as having the possibility to monitor one another's work. Today this process is becoming more computer-assisted and so allows collaboration to take place without any face to face contact. This seems to fit the more mobile nature of today's students, where they can fully contribute, at any time and from any location. This now means that social media is becoming of particular importance in facilitating the exchange of user-generated content and online discussions. As surveying exercises typically involve group work activities, collaborative learning is essential in a number of units within the course.

Video technology can be used as an educational tool for the development and documentation of practical skills (e.g. Frehner et al. 2012). Video analysis is commonly used in sports coaching and education, and professional development of teachers (e.g. Rich & Hannafin 2009). In surveying education, video analysis can be used in two ways, for the demonstration of typical practical procedures, and the recording of student's practical performance.

By providing authentic-like recordings, instructors do not need to spend significant proportions of their time explaining routine procedures, but can focus more on specific problems. In addition, students can follow the video instructions at their own time and pace. Video recording of students' practical performance can be a powerful tool by allowing self-analysis and reflective practice. Furthermore, video evidence can be taken for assessment purposes. An analysis of emerging video annotation tools is provided by Rich & Hannafin (2009).

Simulation-based e-learning (SIMBEL, Kindley 2002) provides a great potential to develop practical skills in a virtual environment. The student is able to learn practical skills required at a given workplace through simulation via real-world scenarios. SIMBEL also provides the opportunity for students to engage, experiment and reflect. According to Slotte & Herbert (2008), the experimental nature is of great importance in allowing students to study cause-and-effect relationships. In addition, SIMBEL is of great importance for training with fragile and/or expensive instruments or training for work in a hazardous environment. As this is also the case in surveying education, SIMBEL can be an effective tool as shown by one example in the following section. Using SIMBEL, students will be prepared for specific work routines without the need for face to face instructions. The saved time can be used by lecturers and tutors to assist students with more specific problems.

In surveying, students typically exercise each practical skill in just one session. As a result, their practical experience is limited to conclusions derived from their own work. One efficient way of improving students' experience is by involving them in peer assessment of other group's work (Falchikov, 2005, 2007). In addition, peers work closely together and may therefore have a greater number of accurate behavioural observations of each other (DeNisi *et al.*, 1983; Greguras *et al.*, 2001).

Based on a teacher's grading scheme (e.g. rubrics), students grade their own or one another's work. While marking, students can learn from their own or another's mistakes and recognise their own strengths and weaknesses. In addition, teachers or tutors can save time in this grading process as the grading is done simultaneously for the whole group. As demonstrated in the following section, this type of evaluation can be assisted by electronic assessment (e-assessment) technologies that are able to automatically mark and provide feedback (Crisp, 2007). The potential of *peer and self-assessment* to enhance student learning in the surveying fieldwork was investigated over a period of two years in the unit "GPS Surveying". According to feedback received from participating students, they found peer assessment to be an efficient active learning tool useful for formative assessment and helped them to address the learning objectives of the fieldwork.

Assessment is focused on improving the learning process by examining the adopted strategies with the goal of enhancing them (Bloxham & Boyd, 2007). It has a focus on future learning that reportedly improves both short and long-term outcomes by helping students to make increasingly sophisticated judgments about their learning (Thomas et al., 2011; Boud & Falchikov, 2007). While e-assessments are particularly suited to assess cognitive skills (e.g. memory), *e-portfolios* can be used to assess practical skills, the main component in surveying education. E-portfolios are becoming more popular in assessing the proficiency of a student on either a particular practical skill or in a general field. This is done by the collection of electronic evidence (e.g. computer assisted) that documents the proficiency. Evidence can be of various types such as written reports, diaries, pictures, audio, video, multimedia, hyperlinks, etc. While being a collection of evidence, an e-portfolio can also help develop communication skills as a result of the assembly of all evidence and presentation of the student's work.

Examples of simulation based e-learning and e-assessment in surveying

In order to adopt a blended learning approach in surveying education, new teaching methodologies and technologies have been implemented. In this paper, two examples from what has been developed are presented. The first example is related to simulation-based e-learning (SIMBEL) and the second example is e-assessment used as a marking, moderation and feedback tool.

Simulation tool for training students

Practical training of students in surveying requires the development of field skills in observation reading, calculations, recording and interpretation of results. To coach and help students to consolidate their knowledge and experience, an online interactive levelling virtual simulation tool was developed (Gulland et al., 2012a). This tool provides helpful formative feedback for students as well as identifying areas where they may need help from a tutor. The feedback is immediate as it is applied within the task itself. This interactive levelling simulation module was designed to address a key basic task in surveying, i.e. levelling. The tool was designed to allow students to practice data entry, fieldwork calculations and checking. Students use the virtual online simulation module to practice self-assessment and rehearse field observations and computations.

The interface simulation module is split into three parts. The first part is to practise reading of the levelling staff using the level instrument, the key field observation component. The second part of the interface is the computations associated with the fieldwork observations. The third component is the checking procedures used by surveyors to ensure both the fieldwork and calculations are correct. Figure 3 shows the interface of the *online simulation for levelling* during its use (Figure 3a) and after it has been carried out (Figure 3b). The simulation tool has been tested and used in the basic surveying unit "Plane and Construction Surveying 100" (PCS100), offered by the Department of Spatial Sciences, Curtin University, as well as other service units in basic surveying.

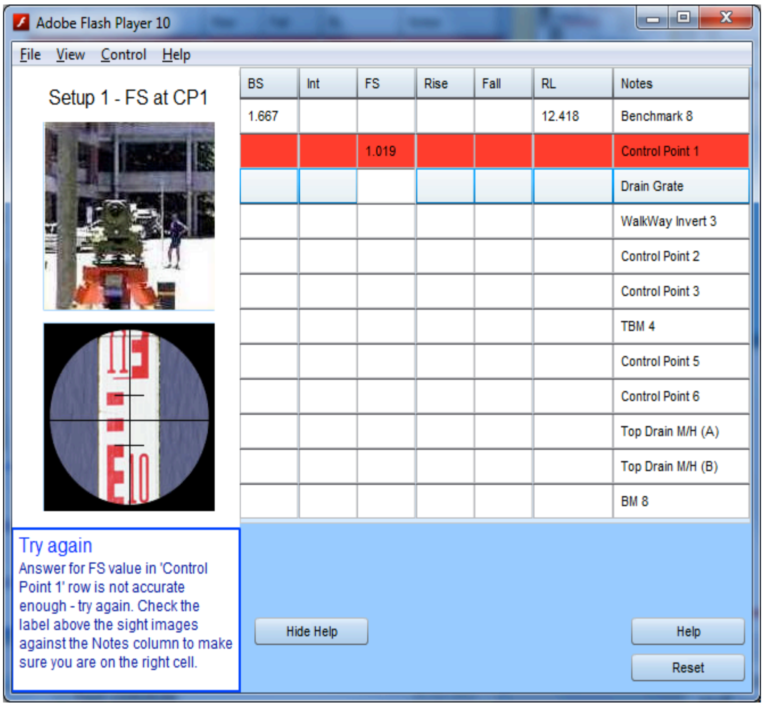

Figure 3a: Interface of the simulation tool during its use

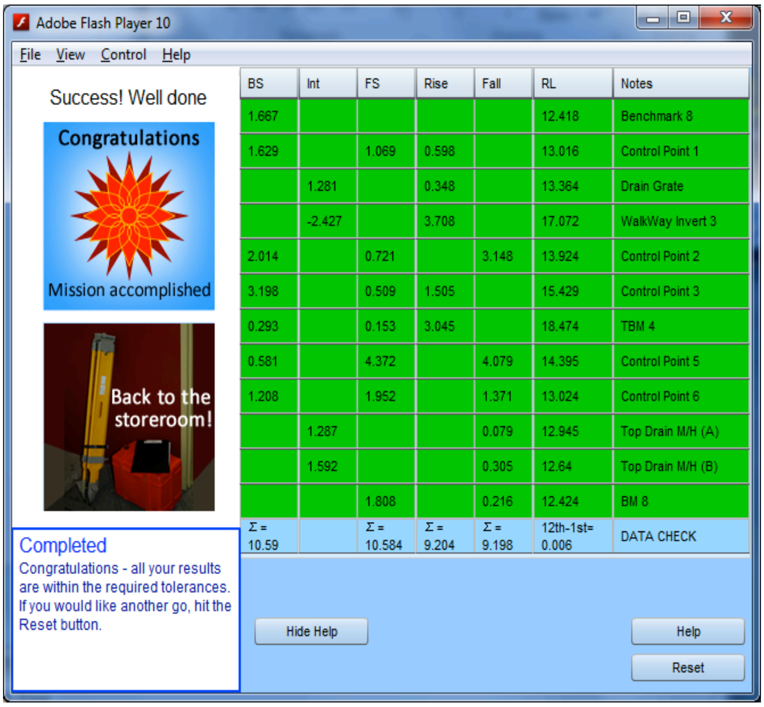

Figure 3b: Interface of the simulation tool after computations

The feedback from students who have used the virtual online simulation tool has been positive in terms of the modules' usefulness in developing their understanding and ability to carry out the levelling field exercise. In 2011, 42 students studying the unit "Plane and Construction Surveying" responded to a questionnaire regarding their experiences using the virtual levelling simulation tool. Students found the interactive simulation tool most useful with comments showing that it was used successfully to practise skills both before and after the field exercise with real-world equipment. The basic questions asked in the questionnaire were:

1. whether the completion of the virtual levelling exercise contributed to allowing students to carry out the field levelling practical more accurately;
2. whether the completion of the virtual levelling exercise contributed to the improvement of their understanding of the computations and checks involved in levelling;
3. the amount of time spent on the interactive tool (< 5 min, 5-15 min, 15-30 min, and 30-60 min).

The responses, given as percentages, by students for each question (out of the total number of participants in the questionnaire) are given in Table 1. The majority of students spent between 5 and 30 minutes using the virtual simulation tool, which is thought to be a reasonable time for students to remain focused and comfortable.

Table 1: Student feedback on the simulation module

Number of participating students	Agree that the tool improves their accuracy	Agree that the tool improves understanding	Time spent using the simulation module			
			< 5 min	5-15 min	15-30 min	30-60 min
42	90.5%	92.8%	9.5%	40.4%	42.9%	7.2%

Marking, feedback and moderation e-tool

Clear definition of the fieldwork tasks and their marking scales associated with different performance levels can help students improve their performance in the practical laboratories. The use of structured grading schemes (for example, rubrics) can serve in this regard as well as help in the moderation of marking when assessment is carried out by more than one tutor. At the Department of Spatial Sciences, Curtin University, a marking rubric was developed to provide realistic marking scales and moderated feedback of the assessors for fieldwork activities. The rubrics were designed to be adaptable to multiple surveying units. The templates have been designed for individual and group practicals as well as camp assessments with multiple tasks. They assist markers to be consistent in their marks. The templates were provided to students before commencement of field sessions. This ensures that students know in advance how each fieldwork activity will be assessed, the mark distribution for each task and the required performance level. This helps stimulate or guide the student's efforts in addressing all fieldwork tasks and objectives associated with the practical work.

The templates (rubrics) have been incorporated for three years into four surveying units at Curtin University (Plane and Construction Surveying, Engineering Surveying, Mine Surveying and Mapping, and GPS Surveying). Tutors for each of these units use a digital copy of the rubrics. The marking feedback e-tools were designed with two sheets. The first provides marks according to performance level in sub-tasks in each fieldwork activity. Four main assessment components were identified for use in the rubrics: fieldwork, field recording, computation and analysis, and presentation of results. The first two components are related to activities performed in the field, whilst the last two components are carried out in the office environment after data collection and verification. These four areas are further broken down into four subcategories that are individually assessed. Each assessment criterion is quantified and varied according to each task/laboratory. The activities for each task have been described and linked to different performance levels that are set to meet the common industry standards for fieldwork execution. A marking scale is linked to each performance category level and the final mark for the assignment is derived from each category level box selected by the marker. Figure 4 illustrates an example of the first sheet of the marking and feedback e-tool.

Preparation of the templates in a digital format has served to streamline their use in the calculation of marks and the statistical analysis of results. In addition, the templates are used as a tool to provide specific feedback to students for each fieldwork activity. The second sheet of the marking and feedback tool presents the assessment outcome where a calculator tool is applied automatically and assigns marks to each student according to

Markers: Select ONE box per row

Feedback and Scale for Marks

Component		0-2: Very Poor	3-4: Poor	5-7: Pass	8-10: Distinction
Fieldwork	Correct instrument setup procedures used	☐ Negligence in setting up the instrument	☐ Poor setup, or instrument not centred or levelled correctly	☐ Setup procedure needs improvement	☑ Good setup procedure
	Maintained instrument setup (centring & levelling)	☐ Setup was not maintained	☐ Instrument not centred or levelled all the time	☑ Maintained but requires some improvement	☐ Instrument setup maintained all the time
	Correct observation procedure used	☐ Incorrect, rough with equipment, or poor safety practice	☐ Poor observation practice	☐ Observation practice needs improvement	☑ Good observation practice
	Closing/checking observations taken before leaving site	☐ No closing/checking was made	☐ Missing main checks or additional observations	☑ Some check obs were missed	☐ All check observations were collected
Field Recording	Use of paper/ digital field notes	☐ No evidence of field results collected	☐ Data and observations incomplete	☐ All data & observations evident	☑ All data & obs recorded in systematic manner
	Observations recorded correctly as observed	☐ No evidence of correct observation methods	☐ Large number of obs not in acceptable format	☑ Has most obs, and format acceptable	☐ All obs recorded and in acceptable format
	Clear & complete field notes presented	☐ Field notes ambiguous & largely incomplete	☐ Field notes incomplete & not organised	☑ Field notes complete but need organisation	☐ Notes are complete & well organised
	Inclusion of index/cover page and north point	☐ No index/cover page & no north point	☐ Index/cover page & north point incomplete	☐ Needs improvement	☑ All are well documented
Computation & Analysis	Basic calculations & reductions performed	☐ No calculations	☐ Significant errors in the calculations	☑ Calculations mostly correct	☐ Error-free calculations
	Closure & checking calculations carried out	☐ No calculations for checking or closing	☐ Significant errors in calculations of checks	☑ Minor misclose or check errors	☐ Close & checks are correct
	Analysis of results (and their errors) performed	☐ No analysis	☐ Incomplete or poor analysis	☑ Satisfactory analysis	☐ Complete & effective analysis
	Acceptable results achieved	☐ No results submitted	☐ Significantly wrong results	☑ Results are mostly acceptable	☐ All are complete and correct
Presentation of Results	Clear & well structured report, index, introduction & references	☐ Report not lodged or submitted after penalty period	☐ Poor structure, missing index/ refs, or spelling/ grammar mistakes	☐ Satisfactory structure, index, intro & refs	☑ Excellent structure, index, intro & refs
	Description of fieldwork & methodology	☐ Very poor reporting, or missing description	☐ Missing part(s) of description	☑ Satisfactory description	☐ Excellent description
	Results, analysis & conclusion	☐ Results or analysis are not included	☐ Poor results, no summary or no concl	☑ Satisfactory presentation	☐ Excellent presentation
	Required plans/ maps/ tables	☐ Required plans/ maps/ tables not included	☑ Poorly prepared, or not all are submitted	☐ Satisfactory but need improvement	☐ Excellent plans/ maps/ tables

Figure 4: Sheet 1 - Marking based on well-defined performance level in each task

performance of each activity scored in the first sheet and percentage of student's contribution. Figure 5 illustrates an example of the calculation sheet component of the rubric. The developed system is designed to provide an accurate, fair and consistent moderation approach that narrows down variability in moderation of fieldwork between different assessors, as they use the same marking scale for different tasks according to a well-defined performance in each activity.

The testing of the first version of the group assignment marking tool has showed that it provided a very useful tool in helping students to both focus on the objectives of each activity and match effort and achievement to the assigned marks. A survey was conducted with students who had used the marking rubric to obtain feedback regarding its usage and value to their understanding of the practical work requirements. The students' feedback showed that they found the marking rubric helpful in assisting their understanding of practical task requirements and in improving their performance and response to marking outcomes (Gulland et al., 2012b). In Curtin's University's online survey system for gathering and reporting student feedback on their learning experiences (*eVALuate*), student satisfaction in the surveying area has risen compared to previous years before the implementation of the marking/feedback tool by 5% on average. The response of the industry received through another questionnaire was encouraging and provided valuable comments and recommendations. These will be taken into consideration in the development of an improved version of the rubrics.

Spatial Sciences - Survey Assessment			
Unit	GPS Surveying 382		
Assessment / Value (%):	Kinematic Positioning by GPS	8 %	
Student	ID	Name	Amount of work (%) *Must total 100%*
1	13651721	Armin Tuka	25
2	13668006	George Symeou	25
3	13980658	Estee Ashbridge	25
4	13648037	Cory Arms	25
5			
Submission Deadline	5:00 pm, October 16, 2010		
Unit Outcomes Assessed	UO1	Use their skills to process GPS data and solve critical GPS problems.	
	UO2	Perform a real time (RTK) and post mission (PPK) positioning.	
	U04	Prepare a GPS Survey report.	
Marking Scheme (For group)			
Component	Mark (1-10)	Feedback	
Fieldwork (35%)	8.3	Good	
Field Recording (15%)	8.3	time of occuping main points in PPK can be recorded to improve point identification.	
Computation & Analysis (20%)	6.7	Some point in PPK processing have percision > 0.05, what did you do with them. You should exclude them, and if they are important point for the map, you should re-survey those points.	
Presentation of Results (30%)	6.7	Good conclusions. The map is not good though and is incomplete. Contours are shown for the lake floor similar to the banks and the surounding land, which should not be the case.	
Group Mark (%)	75.0		
Individual Marks	Member	Final Mark (8)	
	Armin Tuka	6.0	
	George Symeou	6.0	
	Estee Ashbridge	6.0	
	Cory Arms	6.0	

Figure 5: Digital calculator tool and feedback of the rubrics

Peer assessment as a tool to improve learning and teaching

The marking e-rubrics were also used by students of the unit "GPS Surveying" to practise peer assessment in four practical sessions in 2011. To prepare students for the peer assessment, tutors explained the purpose of peer assessment and its value, and at the start of each session, tutors identified, articulated and discussed with students the general criteria that students should use and standards they need to apply to judge the work of their peers. The validity of peer assessment was measured by comparing students' marks with those given by tutors (Brennan, 2001; Cho et al., 2006). Such a validity indicator depends on several factors including students' academic level and abilities, the reliability of the marking schemes and the clarity of the marking instructions. It was assumed that the assessment items are set up correctly; the observation and marking tools are reliable; and the marking instructions and scale schemes are clear and coherent.

Table 2 shows the absolute mean and dispersion (measured by the standard deviation) of differences in marks between peer and tutors' marks for the tested field sessions. Mean and standard deviation were computed as percentages from the total mark for the four subcategories for each of the four identified main assessment components (see Figure 4), namely *fieldwork*, *field recording*, *computation and analysis*, and *presentation of results*. We also empirically checked that the marks included in computation of mean and standard deviation do not include outliers, i.e. the differences between marks given for each fieldwork component from its mean did not exceed three times the value of the standard deviation computed from the overall marks given to this component.

Table 2: Descriptive statistics for differences between peer marks and tutors (as a percentage)

Component/score	mean %	std. dev. %
Fieldwork	6.60	3.71
Field recording	6.41	4.68
Computation and analysis	7.37	1.79
Presentation of results	6.92	4.52

Results in Table 2 show that differences in marks of peer assessors with those of the tutors for the first two components, *fieldwork* and *field recording,* which are carried out in the field, were marginally better than results of the two office work components, *data analysis* and *presentation of results.* This can be explained by differences in the width and depth of the experience between students and tutors when assessing skills, structure and presentation of results. This can be verified when considering that the components that have the largest differences in the office work tasks were *acceptable results achieved, clear and well-structured report elements* and *required plans/ maps/ tables* with average differences of 10%, 9%, and 8% respectively. For the fieldwork components, the subcategories that experience the highest differences were *closing/checking observations taken before leaving site*, and *clear and complete field notes presented* where discrepancies between tutors and peer assessors were 9% and 11% respectively.

These differences indicated to the tutors that more explanation was needed of the assessment criteria and their expectations for the components that have such large differences between peer assessors and the tutors. Therefore, the peer-assessment experiment was a good tool to improve our teaching approach and to identify the activities that required improvements. In addition, based on discussions with students and tracking changes in their reports before and after the application of peer assessment, it is apparent that peer assessment helps students to improve their approaches to problem solving by learning from the mistakes and innovations of others, provision of constructive criticism to peers, following key learning objectives, and appreciating the importance of coming to the final correct solution.

Developing generic skills through authentic learning in surveying

Many generic skills, such as those addressed through the course review, can be developed and reinforced during practical exercises, or through authentic learning. While these skills relate in particular to surveying education, they are also present in many other disciplines that have a high proportion of practical exercises. Depending on the units and course structures, such exercises can address both the development of practical skills (e.g. proficiency) and generic skills associated with problem solving, critical thinking and communication. In this section, we review how common practical exercises in surveying are designed to address these aspects.

Each practical surveying exercise can be defined as a problem that has to be solved. This means that students have to apply their theoretical knowledge in order to apply appropriate practical operations. This process requires problem solving and critical thinking skills (e.g. design the practical operation so as to ensure an optimal outcome) as well as develop practical surveying skills. Communication skills are also necessary which are developed through the design of tasks that require teamwork as well as the analysis and presentation of results.

A common practical exercise in surveying is designed to include the following tasks:

- Identification of the problem and its required specifications (problem solving skill);
- Design and/or selection of survey methodologies that are able to solve problems in an optimal manner (problem solving and critical thinking skills);
- Performance of practical measurements, including appropriate documentation through structured field notes and/or stored electronic data (practical skills and communication skills when performed through team work);
- Processing of all measurements (practical skills);
- Analysis of the processing results. This addresses the identification and removal of errors, the determination of accuracy/reliability to ascertain whether a survey meets required specifications (critical thinking skills);
- Presentation of the survey work and results in a professional and meaningful format suitable for potential clients (communication skills).

In order for students to efficiently perform the above tasks and obtain the needed skills, the lecturers and tutors have to implement innovative teaching approaches that are supported by the blended learning tools discussed in this paper. The lecturers/tutors are consistently required to define challenging surveying exercises that help students to develop both their practical surveying skills and generic skills. They also need to provide professional guidance during the exercise, concerning the use of surveying instruments and surveying methods so as to complete the exercise successfully. This can be further supported by simulating exercises designed to replicate a particular task. Finally, tutors need to provide constructive and timely feedback to students that address the strengths and weakness of their critical thinking and demonstrated skills. This encourages students to address areas of weakness and helps them to take corrective action.

Discussion and conclusions

Facing the challenges of rapid technological changes in higher education, we have shown that a blended learning approach can mitigate some of these challenges. Blended learning will combine traditional classroom learning with online and mobile learning in order to maximise the understanding of theoretical principles, gaining knowledge and development of technical, practical and professional skills. Based on experiences and examples within the Bachelor of Surveying at Curtin University, we believe that blended learning should play a key role in any course review. This is to select the most appropriate methods in teaching and learning to enhance student learning and satisfy the needs of industry and the profession. Furthermore, some blended learning components such as flip teaching and collaborative learning are well suited for enhancing student's active involvement in learning.

Some examples were presented of blended learning in surveying education and information on some key concepts in blended learning. Both provide some insight into blended learning that is likely to become the standard in education in the coming years. In fact, many higher education institutions are already in a transition from traditional classroom teaching to some form of blended learning, by increasing the use of e-learning and e-assessment components.

Surveying education in particular, and education in applied science disciplines in general, heavily rely on authentic learning in order to develop generic, technical and practical skills. In this regard, we have shown that SIMBEL provides a great potential to develop practical skills in a virtual environment. In cases of shortage of time and resources, SIMBEL can provide a high-quality alternative to face to face training. We have provided an example on how SIMBEL was included into surveying education and got an overwhelming agreement from students that the employed tool was helpful in improving their skills and knowledge. Therefore, we believe that SIMBEL should be a key element in any form of authentic learning.

The clear definition of the fieldwork tasks and their marking scales associated with different performance levels in the form of e-assessment templates (e.g. rubrics) can help students improve their performance in the practical labs. The use of structured grading schemes and moderation of marking is vital to stimulate and guide the student's efforts in addressing all fieldwork tasks and their objectives. Preparation of the templates in a digital format has served to streamline their use in the calculation of marks and the statistical analysis of results. In addition, the templates can be efficiently used as a tool to provide specific feedback to students for each activity. Finally, peer-assessment was experimented in surveying fieldwork, and it was found to be a good tool to identify the activities that require improving tutors' explanation as well as to help students gain more experience.

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