Let’s do it: A framework to investigate the affordances of experiential learning environments

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Structured Abstract

BACKGROUND

Experimental learning, traditionally conducted in on-campus laboratory venues, is the cornerstone of science and engineering education. In order to ensure that engineering graduates are exposed to ‘real-world’ situations and attain the necessary professional skill-sets, as mandated by course accreditation bodies such as Engineers Australia, face-to-face laboratory experimentation with real equipment has been an integral component of traditional engineering education. The online delivery of engineering coursework endeavours to mimic this with remote and simulated laboratory experimentation. To satisfy student and accreditation requirements, the common practice has been to offer equivalent remote and/or simulated laboratory experiments in lieu of the ones delivered, face-to-face, on campus. The current implementations of both remote and simulated laboratories tend to be specified with a focus on technical characteristics, instead of pedagogical requirements. This work attempts to redress this situation by developing a framework for the investigation of the suitability of different experimental educational environments to deliver quality teaching and learning.

PURPOSE

For the tertiary education sector involved with technical or scientific training, a research framework capable of assessing the affordances of laboratory venues is an important aid during the planning, designing and evaluating stages of face-to-face and online (or cyber) environments that facilitate student experimentation. Providing quality experimental learning venues has been identified as one of the distance-education providers’ greatest challenges.

DESIGN/METHOD

The investigation draws on the expertise of staff at three Australian universities: Swinburne University of Technology (SUT), Curtin University (Curtin) and Queensland University of Technology (QUT). The aim was to analyse video recorded data, in order to identify the occurrences of *kikan-shido* (a Japanese term meaning ‘between desks instruction’ and *over-the-shoulder learning and teaching* (OTST/L) events, thereby ascertaining the pedagogical affordances in face-to-face laboratories.

RESULTS

These will be disseminated at a Master Class presentation at this conference.

DISCUSSION

Kikan-shido occurrences did reflect on the affordances of the venue. Unlike with other data collection methods, video recorded data and its analysis is repeatable. Participant bias is minimised or even eradicated and researcher bias tempered by enabling re-coding by others.

CONCLUSIONS

Framework facilitates the identification of experiential face-to-face learning venue affordances. Investigation will continue with on-line venues.

KEYWORDS

Affordances, experiential learning, framework, kikan-shido, over-the-shoulder-learning/teaching.

Introduction

The recent growth of the digital economy and the rapid development of internet communication technologies have promised improved online education and training (Bell, Bush, Nicholson, O'Brien, & Tran, 2002). Furthermore, extra pressures exist on education providers to be globally competitive in their tertiary education offerings by improving the quality of their internet-based delivery with the incorporation of new technologies. The ensuing improvements are particularly targeted to support students in remote communities and disabled students anywhere (Lang, 2012). Such steps are seen by many as attempts to preserve the institutions' income levels by evolving "their businesses in new and exciting ways" (Davies, 2012). However, technology-driven innovations in education must be founded on evidence-based curriculum design.

Attempts to address the engineering skills shortage in Australia by increasing graduate numbers (Back et al., 2012), at the same time dealing with budgeting pressures by academic staff cutbacks, have forced the higher education institutions to migrate as many of their courses as possible to online platforms. This will, if not already, include courses that involve experimental learning in laboratory venues[1] (Nickerson, Corter, Esche, & Chassapis, 2007). In order to ensure that graduates are exposed to 'real-world' situations and attain the necessary professional skill-sets, as mandated by course accreditation bodies such as Engineers Australia[2], face-to-face laboratory experimentation with real equipment has been an integral component of traditional engineering education (Lowe, Murray, Li, & Lindsay, 2008; Sarukkalige, Lindsay, & Anwar, 2010). To satisfy accreditation requirements, the common practice has been to offer off-campus students equivalent remote and/or simulated laboratory experiments in lieu of the ones delivered, on campus, in face-to-face venues (Nedic, Nafalski, Ozdemir, & Machotka, 2011). The current implementations of both remote and simulated laboratories tend to have a focus on technical characteristics, instead of pedagogical requirements. The proposed framework attempts to redress this situation by facilitating the examination of the affordances of different experimental laboratory environments for quality teaching and learning.

In 2013, the successful submission for an Australian Government Office of Learning and Teaching (OLT) Seed Project funded the development and verification of this research framework in existing experiential learning environments where students have access to real and/or simulated equipment. The research team comprised of staff from three Australian universities: Swinburne University of Technology (SUT), Curtin University (Curtin) and Queensland University of Technology (QUT); and received in-kind support from The Labshare Institute (TLI). Additionally, members of a reference group of eminent education researchers from Central Queensland University (CQU), University of Melbourne (UniMelb) and University of Sydney (USyd) were available for on-going advice.

Purpose

The provision of quality experimental learning venues has been identified as one of the greatest challenges for distance-education providers (Arbaugh & Benbunan-Fich, 2005; Sivakumar, Robertson, Artimy, & Aslam, 2005). For the tertiary education sector offering technical or scientific training, a framework facilitating the identification of venue affordances will be valuable during the planning, designing and evaluating stages of both face-to-face and online (or cyber) environments where students experiment on real or simulated laboratory equipment.

The term "*affordance*" is used to describe how an object, or an environment, impacts on the actions of its user and is attributed to Gibson (1977). Norman (1990) argued that while

[1] A typical example of an experiential learning environment.
[2] http://www.engineersaustralia.org.au

affordances facilitate use, constraints impede potential uses. Hence, "*affordances*" must be context specific. The framework described in this paper focused only on pedagogical (or learning and teaching) affordances of experimental learning venues for engineering undergraduate courses.

In engineering, as in all sciences, laboratory work targets four broad educational objectives (Lang, 2012):

- conceptual understanding,
- design skills,
- social skills, and
- professional skills.

Some studies involving small numbers of students have found no significant differences in educational outcomes between cyber and face-to-face laboratories (Nickerson et al., 2007; Ogot, Elliott, & Glumac, 2003; Sonnenwald, Whitton, & Magloughlin, 2003). While, other researchers have identified statistically significant differences in the learning outcomes of students who are exposed to different modes of laboratory experimentation that ultimately "could change the effectiveness of [their] education" (Nickerson et al., 2007, p.710). It appears that none of these studies investigated venue affordances. The authors believe that such an investigation may result in identifying the possible causes for the apparently conflicting conclusions.

Furthermore, information on venue affordances will enable multi-campus universities to ensure that their students' experimental learning environments will be of the highest quality, particularly in the event that laboratory test rigs are to be shared online. This is a need that has been identified for the partnering institutions. SUT and Curtin offer identical undergraduate coursework at its domestic and international campuses, while QUT is a multi-campus state-wide university. Furthermore, institutions that participate in the Open University[3] will be in a position to benchmark their online accredited professional courses, which mandate laboratory experimentation, against their on-campus delivery of the same content.

With the availability of new communication technologies the delivery of tertiary education is rapidly changing to facilitate the global demand for flexible quality learning. The two commonly accepted differences for the delivery of experimental learning have been identified as (Nedic et al., 2011):

- less demonstrator supervision in remote laboratories, and
- more opportunities for student collaboration in face-to-face venues.

The ability to delve deeper into these issues by benchmarking the pedagogical affordances in existing and future remote engineering laboratories will be beneficial to the tertiary education sector. The consequentially acquired data may also be used to fine tune both face-to-face and cyber facilities, therefore possibly obtaining a vital advantage in the very competitive market of online education.

Method

The approach reported here is significant because the data collection framework and the associated analysis tools have never been applied in this context.

The underlying methodology is based on the assumption that if: *affordances impact on activity then activity patterns reflect on a venue's affordances, hence on the learning outcomes of its participants*. Some affordances may result in learning outcomes that may not be acceptable to engineering course accreditation bodies such as Engineers Australia, even

[3] http://www.openuniversity.edu.au

resulting in the professional course(s) not being reaccredited and ultimately withdrawn from being offered.

The foundation for the data collection of this framework is the analysis of video data to identify the occurrences of "*kikan-shido*"[4] events, which are described in Table 1. Furthermore as shown in Figure 1 the more familiar "over-the-shoulder learning and teaching (OTST/L)" pedagogy that is observed in experiential learning venues is a subset of *kikan-shido* (Banky, 2007, 2010). Though *kikan-shido* patterns have been used to identify cultural differences in Year 7 and 8 mathematics classes (Clarke, 2002), their use to investigate experimental venue affordances in a tertiary context is clearly innovative.

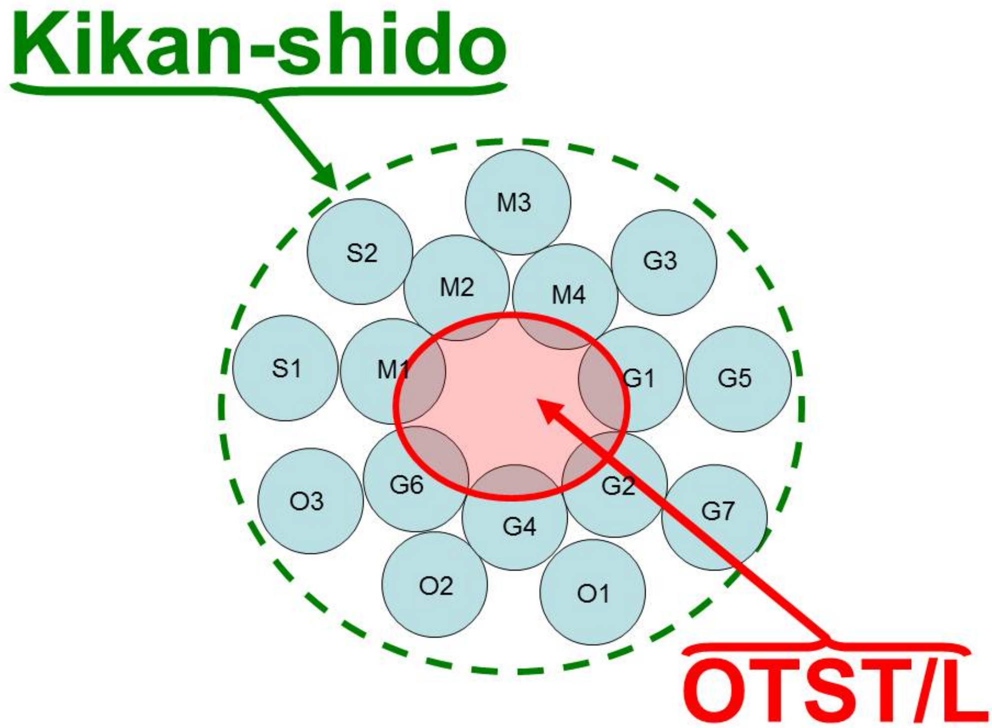

Figure 1: Concept map of the relationship between *kikan-shido* activities (as listed in Table 1) and over-the-shoulder teaching and learning (OTST/L) pedagogy (Banky, 2010, p. 35)

The processing of the collected data utilised a three-layered interpretive model for media-rich research into social interaction, attributed to Wortham and Derry (2006). This model ensures a traceable path from the analysed data, through any intervening depiction(s), back to the recorded data. Furthermore, a benefit of this technique is an implied link between the various data forms and the raw data. Additionally, video recordings of the sessions resulted in permanent records that permitted researchers, and/or any other expert(s), and/or interested parties to repeatedly review the affordances depicted in the video recordings, facilitating easily accessible coding or recoding anytime (Fraenkel & Wallen, 2006).

The identification of data in the video recordings was undertaken with the aid of *Studiocode*® (a video analysis software that was purchased from Studiocode Business Group[5]) that facilitated the annotation of the recorded material as described by Clarke (Clarke, 2001). In order to ensure code-recode reliability, Miles and Huberman's (1994) recommendations were adopted to independently code the recordings on at least two occasions several days apart.

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[4] a Japanese term meaning '*between desks instruction*' (Clarke, 2006)
[5] http://www.studiocodegroup.com/

Table 1: ***Kikan-shido*** **activity definitions (O'Keefe, Xu, & Clarke, 2006, p. 77)**

Monitoring	M1	**Selecting Work** Students are chosen to share their work, methods or thinking with the whole class. This may occur immediately or later in the lesson.
	M2	**Monitoring Progress** Teacher walks around the classroom observing student progress of on-task activity.
	M3	**Questioning Student** An expression of inquiry that invites or calls for a reply from a student that may or may not be related to the current on-task activity.
	M4	**Monitoring Homework Completion** While students are engaged in on-task activity, the teacher observes the completion of homework and may note student achievement or understanding of subject matter.
Guiding	G1	**Encouraging Student** Activity pursued by the teacher intended to motivate, provide support and feedback to individuals or groups of students.
	G2	**Giving Instruction / Advice at Desk** Teacher scaffolds the development of students' understanding by providing information, instruction or advice, focusing on the development of a concept that addresses meaning, reasoning, relationships and connections among ideas or representations, or the demonstration of a procedure.
	G3	**Guiding Through Questioning** A series of specific teacher questions intended to scaffold the development of student understanding of a procedure or concept during the on-task activity.
	G4	**Re-directing Student** Activities pursued by the teacher to regulate the behaviour of student(s) who are perceived not to be paying attention to the current activity, and to support students' on-going engagement during the lesson.
	G5	**Answering a Question** Information given by the teacher when requested by a student.
	G6	**Giving Advice at Board** Instruction or advice given while an individual or group of students work at the board. The instruction or advice may be intended for those students working at the board or may be intended for the whole class.
	G7	**Guiding Whole Class** Teacher walks around the classroom and provides information, instruction or advice intended for the whole class.
Organisational	O1	**Handout Materials** Teacher walks around the classroom distributing materials related to on-task activity.
	O2	**Collect Materials** Teacher walks around the classroom and collects materials from students.
	O3	**Arranging Room** Teacher repositions furniture to enable independent, paired, group or board work.
Social	S1	**School Related** Teacher engages in conversation related to school activities or curriculum.
	S2	**Non-School Related** Teacher engages in conversations of a social nature not related to the subject matter or on-task activity.

The analysis of the video recordings was used to obtain an indication of the relevant venue affordances by identifying the *kikan-shido* activities between:

- student and equipment;
- student and student (or peer-to-peer);
- student and demonstrator.

The partner institutions provided both the participants and the various data collection venues.

Results

Details of the results obtained by applying this framework will be disseminated at a Master Class presentation at this conference[6].

Discussion

The data collected from the video recordings were de-identified, in order to ensure that participants remained anonymous, and subsequently summarised to show:

- the time taken for each *kikan-shido* event, either in seconds or as a percentage of the length of each recording;
- the type of *kikan-shido* event that occurred during each of the recordings.

Following the visual inspection of the data the team concluded that a time-based summary reflected more on:

- the type of laboratory experiment,
- student learning preferences, and/or
- staff teaching styles.

However, a summary of the occurrences of *kikan-shido* events did reflect on the affordances of the venue. The identification of student-student, student-demonstrator and student-equipment *kikan-shido* events highlighted the venue's affordances. Events that were not identified could indicate:

- a potential shortfall in venue affordances, and/or
- there were no requirements for such interactions in the context of the experiential learning, and/or
- the venue did not facilitate such interactions.

The described framework ensured "repeatability" of both data collection and subsequent analysis – a highly desirable feature in case verifications of the analysis were attempted by researcher(s), and/or any other expert(s), and/or interested parties.

Furthermore, the data collected using video recordings were free from of the participants' personal bias and perspective. These are inherently present when using: student/staff experience surveys (Bodner, Wade, Watson, & Kamberov, 2013; Corter, Esche, Chassapis, Ma, & Nickerson, 2011; Lang, 2012), focus groups (Jarmon, Traphagan, Mayrath, & Trivedi, 2009), and selected participants' reflective journals (Jarmon et al., 2009; Lang, 2012). Furthermore, data from formal laboratory reports (Lang, 2012), comparative pre- and post-event testing as well as the statistical analyses of formal assessment results for the learners (Nickerson et al., 2007) are even less direct indicators of the participants' laboratory activities, thereby the venue's affordances.

[6] AAEE2014 Conference Wellington, New Zealand

Conclusions

The implementation of the framework enabled the researchers to analyse video recordings for identifiable *kikan-shido* activities, in order to deduce the affordances of face-to-face experiential learning venues.

The framework evaluation is to continue in a successful seed project proposal[7] that will investigate the affordances of a proposed cyber venue where students will experiment with real equipment while being supervised, on line, with the aid of Google glasses.

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