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Determining the requirements for geographically extended learning (gxLearning): A multiple case study approach

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Blended learning, where face to face delivery is augmented with online components is used widely in Tertiary Education Institutions. With emerging and maturing technology solutions there is an opportunity to leverage them to provide alternative ways to facilitate pedagogically sound student learning. In particular, students may not be able to physically attend the class. The research presented in this paper considers how web conferencing technology, with appropriate hardware and software can be used to integrate face-to-face and geographically separate students (gxLearning), and describes three case studies in a variety of scenarios. The findings suggest the technology needed, and describes some notable advantages such as the ability to record the classes, as well as some significant issues, and will provide guidance to others considering using this delivery mode.

Keywords: blended learning, gxLearning, web conferencing, pedagogies, experiential learning, mobile, field trips, HyFlex

Introduction

As the paradigms of blended learning continue to develop alongside technology adoption and innovation, educators look at ways to leverage the benefits while integrating appropriate pedagogical approaches that support student centered learning. Students are becoming increasingly diverse; educational globalization means they may be in a different location to the institution in which they are enrolled, have a variable number of life commitments and responsibilities, and require the flexibility to be able to learn at a time and place suitable to them. This diversity puts pressure on institutions to provide learning in ways that not only meets these students' demands but also meets the needs of those students who prefer or require face-to-face delivery modes.

Over the last 5 years one lecturer at the Eastern Institute of Technology (EIT) in New Zealand, has provided a flexible learning option where web technologies have supported remote students to participate synchronously in the face-to-face class. Coined "gxLearning" by Verhaart and Hagen-Hall (2012), this method of teaching to "a geographically distributed class, consists of students in a face-to- face mode plus students in a remote location" (p. 111). The gxLearning environment extends the blended learning approach by encouraging the integration of web based infrastructures, communication technologies, tools and software to synchronously engage students both in and out of class. This paper focusses on this gxLearning journey and reports on the successes and challenges as a range of pedagogical and technological approaches have been trialed and either adopted, discarded or adapted over that time. This is presented by case studies highlighting how the gxLearning environment enabled remote students' synchronous participation in face-to-face (f2f) classes and on a field trip.

Outcomes from each case study are analysed as a whole, and suggested requirements consolidating the technologies, pedagogical and theoretical approaches are presented. This addresses the research question, "What are the requirements for effective learning in a geographically extended learning (gxLearning) environment". The requirements provide guidance for educators considering extending f2f or blended course offerings into the gxLearning paradigm.

GxLearning

In allowing flexibility and convenience with attendance modality, the gxLearning environment (Verhaart & Hagen-Hall, 2012) primarily promotes an 'enabling blended environment' and encourages pedagogical transformation where students may experience dynamic interactions (Bonk & Graham, 2006) with both the technology and their peers. Development of reliable web conferencing systems requiring little infrastructure to implement, has further supported these blends by enabling remote student participation as part of a normal f2f classes. Adobe Connect, as an example of these technologies, provides a variety of synchronous communication channels and activity enabling features; video, audio, chat, shared whiteboard, presentation (Adobe, 2016) and web 2.0 technology integration. Variations of Verhaart and Hagen-Hall's (2012) gxLearning paradigm has alternatively been described as Hyflex course design by Beatty (2007), blended synchronous learning (Bower, Kenney, Dalgarno, Lee & Kennedy, 2013) synchronous hybrid delivery (Butz, Stupnisky, Petersen & Maherus, 2014) and synchromodal classes, synchromodal hybrid, synchromodal learning (Bell, Sawaya & Cain, 2014).

Beatty (2007) developed the Hyflex model to specifically include online students in on-campus classes. Both f2f and online students use the same course within a LMS, engage in activities and occasionally use web conferencing tools to engage in topical discussions. Students could cross from one participation mode to another confident they would have an equivalent learning opportunity. Miller, Risser and Griffiths (2013) used the Hyflex approach to provide a large class with attendance options. Using Adobe Connect and other synchronous web technologies, the lecture slides and audio feed was streamed to the remote students from the classroom and also recorded for later viewing. While students' reported increased participation in class and appreciation of the recordings, technology issues often disrupted the lecture flow. Both Beatty (2007) and White, Ramirez, Smith and Plonowski (2010) discovered the multimodal delivery method placed an increased load on a normal class teaching demands and used a second instructor to manage the remote student chat and technology requirements. Bell, Cain and Sawaya (2013) observed a similar phenomenon and introduced the "Technology Navigator" in that role as they too explored ways to teach courses where not all the students were physically able to attend class. Like Verhaart and Hagen-Hall (2012), the idea of both video conferencing and web conferencing was considered as solutions to link classrooms and people in various configurations. Bell et al. (2014) trialed three scenarios; classroom to classroom, classroom to online with a shared in-class communication portal, and classroom to online with students having personal portals to the online environment. In each case, web conferencing tools were trialed and the best solution chosen for the given number of students and scenario. Key challenges to both gxLearning and the synchromodal solutions were stated as the variable quality of the internet connection and being able to provide an optimal audio and video solution (Verhaart & Hagen-Hall, 2012; Bell, Sawaya & Cain, 2014; Day & Verhaart, 2015).

In a different approach, Butz et al. (2014) explored the relationships, self-determination and motivation of students in a class where both online and on-campus students were taught synchronously using audiovisual technology. As a result of this study, it was found that the students generally reported similar experiences with their satisfaction, motivation and perceived success, however the online students did feel less relatedness and belonging than their in-class peers. As a further extension to the solutions described by Verhaart and Hagen-Hall (2012), Beatty (2007) and Bell, Sawaya and Cain (2014), Day and Verhaart (2015, 2016) used the gxLearning environment to enable field trip experiences where face-to-face and remote students used mobile devices to participate and communicate while in the field. In all cases, the importance of high quality audio and video feeds was highlighted as essential for a good student experience.

Case Studies

This research presents three case studies demonstrating gxLearning across a variety of scenarios. Each case study is unique in that either the technologies used, the pedagogical approach taken or the underpinning theories applied to the case differed. While being cognizant of the need to provide students with an authentic learning experience and to continually improve teaching and learning within the gxLearning modality, these changes were informed by the learning from each case over the duration of the study. The cases are reported in order of occurrence, from 2012 - 2016. The participants in these case studies were students studying papers within the Bachelor of Computing Systems (BCS) degree at the Eastern Institute of Technology. In each case, students could participate in the scheduled face-to-face class, or attend synchronously but remotely, using the Adobe Connect web conferencing technology as the gxLearning enabling environment.

Case 1: 2012 - 2016 enabling remote participation

GxLearning using the Adobe Connect web conferencing system was first used at EIT 2012, allowing a student located at the distant Gisborne campus to attend. This course was offered in a blended mode where f2f was supplemented with online content and activities, but required a few hours per week of f2f time. Although video conferencing (VC) facilities between campuses was available, it was considered "over-kill' to dedicate a full VC suite for one student (Verhaart & Hagen-Hall, 2012). Benefits of cross campus training using a web conferencing system had previously been identified by Fletcher (2008). Although several challenges were identified; time constraints, technical issues and less interactivity, web conferencing was seen as the solution to a student enrolment/attendance issue when there was no alternative option. From this initial offering of gxLearning, several classes over 5 years have used this scenario allowing remote participation by students unable to attend class. The configuration of software and hardware has remained largely unchanged; Adobe Connect as the gxLearning environment, a webcam and microphone for video and audio and the remote students access the online class on their PC's, laptops, tablets or smartphones. Students in class are encouraged to login to Adobe Connect, and each class is recorded for later viewing and revision.

Adobe Connect provides a number of features enabling the class lecturer to share lecture notes, screen demonstrations, web links and white board notes as well as providing the communication stream between the class and the remote students. The remote students are able to use their own webcams and microphones or the text chat feature of Adobe Connect to communicate in return with the class lecturer and other in class students. The gxLearning environment has also enabled international guest speakers the ability to interact with both the face-to-face and remote students providing a global perspective in the context of their studies.

Case 2: 2015 field trip

EIT's Digital Learning Technologies (DLT) course aims to provide students with practical experience of implementing digital technologies in an education or training environment (EIT, 2015). It also introduces students to related pedagogical approaches and learning theories, and is an ideal course to experiment with technology/pedagogy relationships while meeting the learning requirements. In 2015 students participated in a field trip, visiting EIT's School of Music to experience how digital learning technology is utilized in a classroom setting. Field trips are recognised as providing an opportunity to increase student engagement, knowledge and motivation (Behrendt & Franklin, 2014) while also providing a learning experience that connects class based learning to the real world (Wu, 2009). Based in Kolb's (1984) experiential learning theory the field trip encouraged students to experience, reflect and review, and finally apply their learning to a new scenario (in this case, the production of their own digital learning artefact). Students who were unable to attend the field trip f2f, participated virtually by logging in to the class Adobe Connect session. This session was managed using two mobile devices controlled by the class lecturer and attending education adviser. An iPad streamed the audio and video and a laptop was used to facilitate chat based discussion and questioning with the remote students.

Students who attended the field trip were encouraged to use mobile devices to capture evidence of their visit, make notes and upload their photos or videos to a shared class blog. As an assessed item, the students were asked to share in the blog:

Reflections on the issues surrounding the use of digital technologies during the field trip,
List the strengths, weaknesses, opportunities and threats when using these technologies, and
Reflections on some of the considerations when designing learning for remote participation (Day & Verhaart, 2015).

The remote students also completed the assessed activity, and offered a unique perspective on the experience. Eighteen students attended the field trip face-to-face and ten students attended remotely.

Case 3: 2016 field trip

In the early part of 2016, the DLT students were again taken on a field trip, this time to a sustainable house project located near campus. While the project was of interest, it was the use of technology while in the field that was the primary focus. The students were to use mobile technologies not only to record field based evidence, but also to experience the capabilities of current mobile technologies to enable remote student inclusion within an Adobe Connect supported gxLearning environment. As an extension of the 2015 field trip, this trip was not supported by the campus Wi-Fi infrastructure. Two cycles of Kolbs (1984) experiential learning cycle (see Figure 1) was used as the theoretical foundation when planning this field trip. The first cycle was the learning undertaken by the session planners (course lecturer and the education adviser) during the field trip planning visit and the second is that of the students during the actual field trip (Day & Verhaart, 2016).

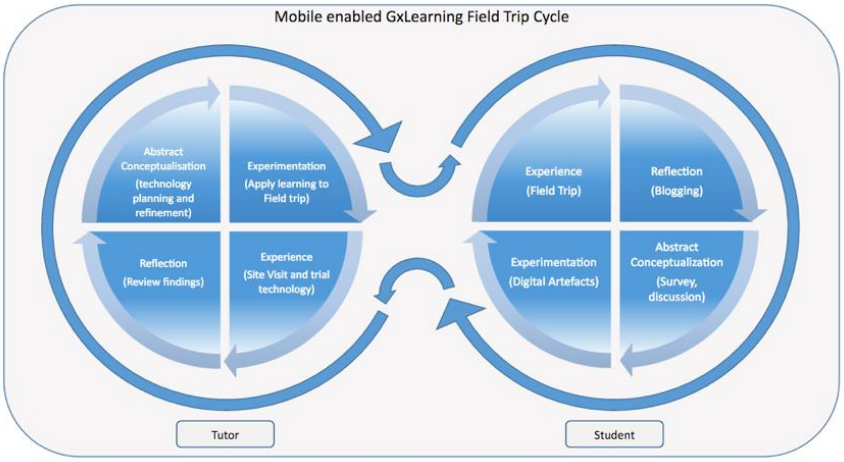

Figure 1. Two cycles of experiential learning used in this case study (Day & Verhaart, 2016)

As the field trip was planned outside the institutes Wi-Fi coverage area, a pre-site field visit by the course lecturer and education adviser was done. This tested the technologies required, allowed a "dry-run", and helped to decide on the strategies needed. The visit was also attended by the project manager (a PhD student) who would host the students during the actual field trip. As stated by Scarce (1997), "good field trips are made possible by instructors' attention to detail" (p. 3). The pre-field trip visit revealed varying 3G/4G data connection strengths and speeds with a high degree of latency. This resulted in a proposed field configuration of one mobile device to deliver the gxLearning video stream and the other to manage the audio and chat capabilities (Day & Verhaart, 2016).

On the day of the actual field trip, outcomes and expectations for the trip were explained to students in a short class session. Mobile devices running the Adobe Connect app provided the communication link to remote students while in the classroom, during the short walk to the field site, and the field visit itself. As planned, one smartphone was dedicated to managing the audio and chat streams with the remote students and another the video feed. However, students tested the limitations of their own mobile devices by communicating with their remote peers using the Adobe Connect app chat feature, and photographing and videoing their observations. Due to a miscommunication between the field trip organisers and the project manager, it was left to the class lecturer to introduce and explain the project. This was achieved without difficulty due to the earlier site visit and discussions. Following the field trip, students completed an individual reflective blog post detailing their technology experiences, reflections on the gxLearning environment as a remote field trip enabler and to offer recommendations for improvement. To complete the learning cycle, students engaged in discussion on how mobile and gxLearning may be used in the context of developing their own learning objects.

Research Methodology

Purpose

The purpose of this research was to determine the requirements needed for effective learning in a gxLearning environment. Over the past five years, a variety of technological, theoretical and pedagogical approaches have been taken to deliver several courses in this way. The delivery of these courses form the foundation of the multiple case study approach taken here. Due to the complexities of implementing the gxLearning environment, and the large number of variables that needed to be considered, case studies provide a methodology by which the phenomenon can be studied in both a longitudinal and holistic manner. Yin (2014) describes the use of a multiple case study approach as suitable when 'replication logic' reveals similar results. These results can then form the basis of a theoretical framework where conditions and outcomes can be constructed. This research was approved in 2012 by EIT's Research and Ethics Approvals Committee under the umbrella of approval granted for gxLearning and the #npf14lmd mobile project research. An updated ethics approval was submitted and approved in 2016.

Method and data collection

Multiple sources of evidence form the empirical evidence within each case study, and includes a longitudinal survey capturing student feedback, a focus group, student reflective blogging, lecturer and education advisor reflections and direct observations. Together the findings offer multiple perspectives for analysis, interpretation and consolidation into a model for effective gxLearning. For this study, responses that specifically mention technology, teaching approaches, communication, benefits or challenges to learning have been extracted.

Longitudinal survey
A small online survey has been gathering feedback from students that have participated in classes using the gxLearning environment; DLT (2012-16), Advanced DLT (2015-16), and Advanced Internet and Web (2012-16). The survey captured use, benefits, disadvantages, and level of engagement and enjoyment when using Adobe Connect for remote participation. Likert items that articulated a variety of usage scenarios, with 1-5 scaling (1 indicating an awful experience and 5 a great experience) and an unstructured answer area was included, as was a selection of demographic questions, such as gender, age range and perceived computer ability. The anonymous survey was distributed electronically to students through the learning management system course pages. Since it was first distributed, 83 valid survey responses have been collected. From those responses, most (63) indicated they have had a good or great overall experience, 17 indicated a neutral experience and 3 indicated a bad or awful experience. Most indicated they have been engaged, or very engaged in the course they took, 59 indicating that the technology used in the course positively influenced their engagement. Previous research resulting from this survey indicate that students appreciate gxLearning because of its flexibility, access and convenience (Verhaart & Hagen-Hall, 2012; Day & Verhaart, 2015).

Class and student blogs
Students participating in the 2015 (Case 2) and 2016 (Case 3) DLT classes were asked to post reflective comments about their experiences into a joint class blog or individual blogs respectively. The reflective feedback and comments have been extracted and added to the collection of evidence for analysis. Combined, this represents evidence gathered from 53 students who blogged over a two-year period.

Focus group
In 2015, the DLT students (Case 2) also participated in a focus group that took place in normal class time. Questions were displayed in a shared Google Doc, allowing students working remotely an opportunity to add their answers and feedback to the document. The focus group questions asked the students to further describe their experiences of attending (either f2f or virtually) the field trip. Comments were transcribed from the Adobe Connect video recording of the class, from the Google doc and from the chat stream within Adobe Connect. The focus group discussion included 28 students, 12 of whom were in the face-to-face class and 16 who attended virtually. The transcribed comments have been considered as part of the overall evidence.

Lecturer and Education Advisor reflections and observations
Over the course of these case studies, one lecturer has been the primary facilitator of all classes. Comments, observations and reflections from the teaching perspective have been collected since 2012 and record the changes, challenges and successes. An education advisor in learning technologies has also been involved in one course in the role of guest lecturer and offers alternative perspectives to the events described in the case studies.

Case Findings and Analysis

To develop an understanding of the requirements to successfully implement gxLearning, student responses that specifically mention technologies, teaching approaches, interaction, communication, and benefits or challenges to learning were extracted from the survey, focus group transcriptions and blogs. These were consolidated into representative themes which are supplemented by lecturer and education advisor observations and reflection.

Technologies

Adobe Connect
While students appreciate the flexibility and convenience offered by the gxLearning environment, their experiences as remote students joining in a f2f class offer valuable insight into overall effectiveness of Adobe Connect as the enabling technology. Students in the DLT class appreciated being able to explore a digital technology directly in the context of their studies, “I came to know about new technologies and how to use them” and “I got a chance to explore modern learning technologies”. Students also showed an appreciation of the technical requirements when using this modality, “The more complex and more useful technologies go often hand in hand with higher requirements in terms of hardware and technical understanding” and noted that it is “important that the technology is easy for people to understand and use, such as Adobe Connect”. Negative feedback over the last 3 years has focused consistently on the poor audio quality “sometimes the audio is not very clear” and this is particularly problematic for international students “The sound quality is really poor. Especially for non-native speakers it is even harder to understand the lecturer when recorded in a poor sound quality”. Despite the ongoing audio issues, one student noted that Adobe Connect was “excellent for video conferencing online”. At the simplest level Adobe Connect allows some collaboration tools such as a white board and break out rooms for discussion. The text chat mode is very useful, however this becomes hidden during screen sharing making it difficult for one lecturer to manage both the classroom and online during these times. Adobe Connect works best with uploaded presentations but screen sharing of applications, browser based content and video provides the greatest versatility when teaching. Although the text chat is difficult for the lecturer to manage, it does allow students both online and

f2f to interact and back channel discussions do happen.

Classroom
The f2f students often had opportunity to interact with their remote peers using their own technologies in class, or, if the class was held in a computer lab, to use the technologies there. Although a small number of classrooms with VC facilities are available, the demand on these rooms are heavy, was considered not a good use of resource for limited student numbers, and was restricted to other campus VC rooms. Although experience showed students had the best interactive experience if they had their own devices, some did provide their thoughts about the classroom technologies. A few noted the time it took to set up the technologies, one student commented that it, "always takes some time so set everything up" and made reference to the limitation of hardware "if you do not have the appropriate hardware, the software's potential cannot be fully used".

Setting up the classroom in order to use Adobe Connect in the gxLearning environment requires many layers. A typical sequence to get the technology ready is as follows;
1. Lecturer's computer (the meeting host), webcam, projector and smartboard (where available) configured
2. Zoomit (screen zoom and annotation tool) installed (if no smartboard is attached)
3. Adobe Connect run in Internet Explorer, and setup process completed; recording feature configured, started and paused; microphone and webcam enabled and screen shared
4. Check remote students can hear the audio, see the screen share and check if they have a microphone and want it enabled (rarely in large classes)
5. Start web browser and load teaching material
6. Start recording when ready.

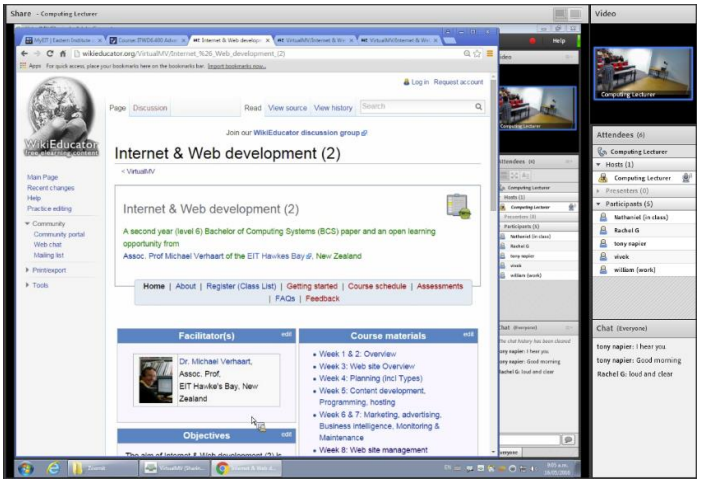

Figure 2. Screenshot of completed Adobe Connect setup

In order for a single class lecturer to manage both the class presentation, screen sharing and remote student chat and video feeds, all needed to be displayed on the primary screen to allow for easy monitoring. To achieve this, the full screen was shared within Adobe Connect, giving a view within a view to the remote students and in the recording (see Figure 2). This can be avoided if each class has the luxury of Bell, Cain and Sawaya's (2013) "Technology Navigator" to manage the remote cohort on a separate device.

In an attempt to improve the audio and video feed the class lecturer has experimented with various webcam, microphone combinations and solutions. A small USB powered web-cam was initially used and was placed facing the lecturer. Sound quality from the lecturer was acceptable, however due to the angle, questions from the class were inaudible to the remote students. This was mitigated by the lecturer repeating the class questions as they arose. However, in order to try and capture the student questions in the moment, a USB extender cable was used to position the webcam further back into the classroom. Unfortunately, the audio degraded too much to be useful. Next a conference camera/microphone solution was trialed. This required a lengthier set-up process, and still the audio quality was at an unacceptable level. In all cases, the narrow fields of view from the different cameras limited the remote students' view of the class.

The next equipment trial consisted of a wide angle webcam (90degree) with a magnetic mount attached to the whiteboard positioned at the front of the class. This allowed a side view of the lecturer and some of the class to be visible to the remote students. As long as the lecturer stood facing the microphone this was an improved solution. A USB 3 extension cable was needed to connect this setup to the lecturer computer and provide the extended reach needed without degrading the audio. In the student observations, one noted "ok if the audio can be improved, maybe if the tutor has a separate microphone that is attached to him/her". A dual microphone (lapel and handheld) solution is currently being trialed, and daisy chained microphones are being considered.

While proving effective, an issue is that the battery life of the roving microphones is limited. The use of USB power banks with battery life indicators is being explored as a solution.

A separate issue is the ability of remote students to talk back to the class. While it would be desirable to have rooms set up with quality speakers this is not often the case. After much experimentation a wired USB powered speaker of at least 20 watts was found to be suitable for a computer room holding 30 students. It should be noted that remote students are reluctant to talk to the class, and to maintain audio quality one participant only should have the microphone enabled. The variety of technologies trialed are shown in Figure 3 and listed in Table 1.

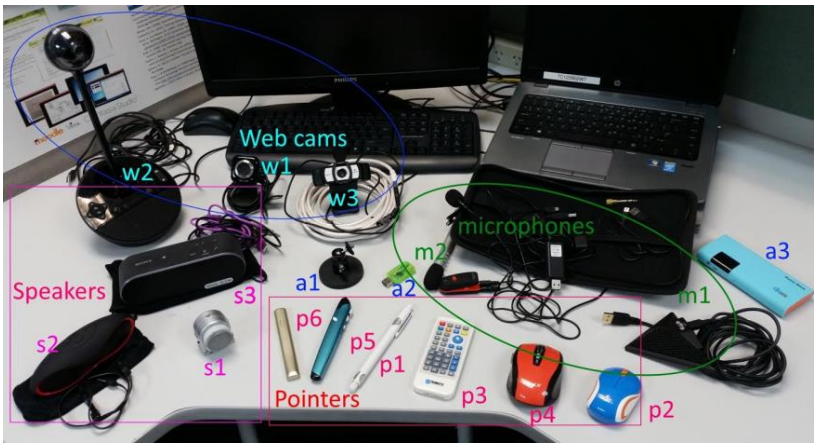

Figure 3. Technologies used

Table 1. List of equipment trialed and used

Speakers	Webcams	Microphones	Pointers	Accessories
s1 Microspeaker 2W *s2* Bluetooth/wired speaker 4W *s3* Sony Bluetooth/wired speaker (20W)	*w*1 Microsoft *w2* Logitech Conference Camera (ET) *w3* Logitech C930e 90deg	*m1* Multidirectional triangle (conferencing mic) *m2* dual lapel and portable	*p1* Smartboard pen *p2* Wireless Mouse *p3* multifunction remote (include mouse paddle) *p4* Bluetooth mouse *p5* Pen mouse *p6* Air mouse	*a1* Magnetic GoPro mount for webcam *a2* USB audio dongle *a3* USB power bank

Remote

Remote students reported using a variety of technologies to access the gxLearning environment. Notable was their use of mobile technologies, indicating the ease at which they could access class from anywhere, “So I could always attend the class through my cellphone at my work easily”, “Even without a computer, I can still use a smartphone to attend class. I can also bring a laptop with me on a trip and watch on there or borrow someone else's machine”. Students also experienced the odd technological issue, “I couldn't get my microphone to work but will endeavour to rectify this for next time” and at times struggled with poor internet connection “If you have a slow bad internet nothing can be done at a feasible level”. Adobe continue to improve Connect giving better experiences on student devices. Once relying on Flash technology, Adobe Connect is moving towards a fully featured HTML5/Web Real Time Communication (WebRTC) application, and ongoing improvements in this area should see more students using the gxLearning environment while on the move.

Mobile

The field trip case studies highlighted a number of issues when using mobile for gxLearning. Firstly, any issues experienced are exacerbated when using mobile devices with either Wi-Fi or 3G/4G connectivity. Sound quality degrades due to network latency and hardware restrictions and the Adobe Connect mobile app is not as developed as the desktop version. However, mobile does enable remote student participation. Mobiles can serve multiple purposes; connecting cohorts of students, enabling communication and for capturing multimedia for reflective purposes. Mobile technology capability is evolving, data speeds increasing and therefore the use of mobile is seen as a way to continue supporting field based learning for diverse student cohorts.

Communication and cloud tool integration

The gxLearning environment acts as a communication channel, facilitating discourse between classroom and remote students. To this end, the ability of the environment to support effective communication across a number of channels is paramount. Students had mixed views on this ability. Some considered it a lesser experience, "The inherent remoteness of presence and sound making for a lesser quality learning experience..." and with reduced interaction, "Student lose interaction with other classmates and tutor". Although voice and/or text features were available to students, some implicated the technology more as a barrier than an enabler; "chat is a bit labored" and "Asking questions was tricky. First the microphone had to be turned on (It's off to reduce interference), then you had to wait for a pause in the lecturers speaking to pop your question in, or wait until they had finished speaking". Other students reported on the communication aspects positively, "you can talk to other people privately if you so wish" and "Questions seemed easier to ask and be answered". Some appreciated the diversity offered, "It was cool having some people in different cities being in the class and talking" and "using this technology enables you to connect with students from other institutions and provides a great Q & A forum".

Although research reveals that web conferencing can increase engagement, particularly with online classes (Gurell, Kuo & Walker, 2010), the challenge is to address the issues reported by students within the mixed mode gxLearning environment. It has been observed over the course of these case studies that remote students are often reluctant to talk back to the class. To enable their participation, particularly in discussion activities, such as brainstorming, contributing to written discussion and communicating progress, additional technologies, such as Google Docs, have been introduced as part of the wider ecosystem. This provides alternative, active and collaborative workspaces for both the f2f and online students.

Other engagement strategies included: students' blogging to encourage reflective practice and as part of the course assessment; social media streams to encourage sharing of ideas and resources and the use of wikis (e.g. wikiEducator) to enable collaborative authoring; and actively using cloud tools as part of their investigation into learning technologies.

Pedagogical approaches

The gxLearning environment supports multiple teaching and learning approaches. Lectures provide an instructivist approach; group activity with Google Docs, discussion and collaboration fulfil the needs of a constructivist approach and interaction within social networks support the connectivist approach. The environment also enabled experiential learning in the form of the field trips, and supported a variety of student learning preferences with Adobe Connects multi-modal communication channels. All these approaches have been trialed and successfully implemented during the course of these case studies.

Student participants reflected on the pedagogical implications of the gxLearning environment comparing their f2f experiences with that of attending remotely. One student was particularly insightful about the necessary teaching skills, "The teacher must be skilled (and preferably at expert level) across all domains: pedagogy, instructional design, the subject material to be presented, the technology used for delivery and managing two audiences before, during and after delivery". As expected, some students naturally preferred f2f learning, particularly the immediacy of the interactions and the perception of a greater personal atmosphere, "Being physically present enables you to interact more fully with lecturers and the class and be aware of more", "Face-to-face meeting is much more better because you get to see the whole room, get to see clear writings on the board and not just the one the tutor is sharing on the screen and be able to raise a question which the tutor can address right away". Others found gxLearning equally effective, "Brilliant, just as effective and suits my way of learning" and appreciated the sharing opportunities offered, "Collaboration capabilities, sharing work in one easy to manage place". One student offered thought on how to enhance the gxLearning process, "Solutions to manage the workload include teaching assistance with the audience(s), technical assistance to set-up and troubleshoot the technology; administration assistance (or automation) to complete class attendance records and assistance with instructional design and implementation".

Recordings

Adobe Connect also comes with a recording feature where the activity within the environment can be saved as a video file and made available for viewing at a later time. The benefits of this was also appreciated by participants, "I could review the session more than once later at home. This ensured that I understood the lesson objectives, activities and was able listen to any questions or feedback from the students and lecturer who were in attendance", "I like being able to catch up on a recorded session if there was a particular topic that the tutor covered that I just wasn't grasping the concept of. Apa referencing for example. or the methodology for project proposal. it was beneficial because I was able to go back and review the guest lecturer that spoke about this topic". Consistently comments included the words "review", "revise" and "repeat".

Conclusion, requirements and recommendations for gxLearning

This research, while ongoing has highlighted a number of requirements needed to ensure successful learning and teaching in the gxLearning environment. In all cases, the quality of the hardware and infrastructure had an impact on the student experience, whether it be lesser computing power, slow internet connection, or under spec'd audio or video equipment. A poor audiovisual experience and other technological difficulties are major contributors to noise, those disruptions that interfere with communication and the learning process. In some cases, international students experienced additional noise, where the time taken to understand and comprehend as part of their learning process was lengthened due to English being their second language. Notable was the importance of the class recordings as a tool to allow these students a way of going back over the class session in their own time and at their own pace.

Several key dependencies to providing students with a valuable gxLearning experience were revealed during the study. Paramount to students learning was the provision of clear audio, however, students' participation and reflections indicated that even with poor audio there were many advantages in providing the gxLearning option. Also important was their ability to participate 'on the go' and independent of location. Some remote students felt the isolating effects of not being in class, however the class lecturer has integrated a variety of web based activities that allow multiple opportunities for both cohorts of students to engage and interact. Recordings proved invaluable, with students repeatedly indicating their appreciation of these for revision, catching up on missed sessions and preparing for assessment.

The gxLearning environment supports multiple pedagogies approaches. However, a degree of creativity and confidence, and a pragmatic approach by the educator is needed to cope with both the technologies used, and the varying technological abilities of the students, both in and out of the classroom.

Limitations

These case studies are limited by the small sample size and the unique contexts in which they occurred. The students participating in learning using the gxLearning environment are primarily second and third year undergraduate IT students. As such, they have the technological skills and digital literacy capability to understand, use and troubleshoot the technologies used.

Future work

As these case studies show, the quality of the student experience has largely depended on the quality of the devices used for audio and video communication. Over time, newer technologies will be tested and integrated into the gxLearning environment as they become available. Furthermore, it is intended to produce a model of learning that reflects the theoretical and pedagogical approaches, the technologies used, and the practicalities of learning and teaching in this way. It is envisaged that this model be used as a guide by educators who wish to extend their classroom teaching and synchronously inclusive of remotely located students.

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