Accepted Manuscript

Design and Implementation Factors in Blended Synchronous Learning Environments: Outcomes from a Cross-Case Analysis

Matt Bower, Barney Dalgarno, Gregor E. Kennedy, Mark J.W. Lee, Jacqueline Kenney

PII: S0360-1315(15)00075-5

DOI: 10.1016/j.compedu.2015.03.006

Reference: CAE 2814

To appear in: *Computers & Education*

Received Date: 24 December 2014

Revised Date: 4 March 2015

Accepted Date: 5 March 2015

Please cite this article as: Bower M., Dalgarno B., Kennedy G.E., Lee M.J.W. & Kenney J., Design and Implementation Factors in Blended Synchronous Learning Environments: Outcomes from a Cross-Case Analysis, *Computers & Education* (2015), doi: 10.1016/j.compedu.2015.03.006.

Computers and Education – Title Page

Article Title

Design and Implementation Factors in Blended Synchronous Learning Environments: Outcomes from a Cross-Case Analysis

Author Names, Affiliations, and Contact Details

Matt Bower [a, *], Barney Dalgarno [b], Gregor E. Kennedy [c], Mark J.W. Lee [d], Jacqueline Kenney [a]

a. School of Education, Macquarie University, NSW 2109, Australia
b. uImagine Digital Learning Innovation Laboratory, Charles Sturt University, Locked Bag 588, Wagga Wagga, NSW 2678, Australia
c. Centre for the Study of Higher Education, The University of Melbourne, VIC 3010, Australia
d. School of Education, Charles Sturt University, Locked Bag 588, Wagga Wagga, NSW 2678, Australia

* Corresponding author. School of Education, Macquarie University, NSW 2109, Australia. Tel: +61 2 9850 8626/4 00312932; fax: +61 2 9850 8674.

E-mail addresses: matt.bower@mq.edu.au (M. Bower), bdalgarno@csu.edu.au (B. Dalgarno), gek@unimelb.edu.au (G.E. Kennedy), malee@csu.edu.au (M.J.W. Lee), jacqueline.kenney@mq.edu.au (J. Kenney).

Design and Implementation Factors in Blended Synchronous Learning Environments: Outcomes from a Cross-Case Analysis

ABSTRACT

Increasingly, universities are using technology to provide students with more flexible modes of participation. This article presents a cross-case analysis of blended synchronous learning environments—contexts where remote students participated in face-to-face classes through the use of rich-media synchronous technologies such as video conferencing, web conferencing, and virtual worlds. The study examined how design and implementation factors influenced student learning activity and perceived learning outcomes, drawing on a synthesis of student, teacher, and researcher observations collected before, during, and after blended synchronous learning lessons. Key findings include the importance of designing for active learning, the need to select and utilise technologies appropriately to meet communicative requirements, varying degrees of co-presence depending on technological and human factors, and heightened cognitive load. Pedagogical, technological, and logistical implications are presented in the form of a Blended Synchronous Learning Design Framework that is grounded in the results of the study.

Keywords: blended synchronous delivery mode; hybrid student cohorts; computer-supported collaborative learning; learning design; teaching/learning strategies

1. Introduction

A persistent problem since the advent of online learning has been the need to bridge the divide between students attending on-campus classes and those learning at a distance, in order to give all who are undertaking a particular course or unit of study equivalent learning opportunities (Popov, 2009; Turoff, 1999; Waddoups & Howell, 2002). In a higher education landscape where students typically must manage multiple competing demands on their time (James, Krause, & Jennings, 2010), even those enrolled in the traditional, campus-based mode are finding it increasingly difficult to come to class on a regular basis (Gosper, Green, McNeill, Phillips, Preston, & Woo, 2008). Many of these students relish face-to-face (F2F) interaction and socialisation with their instructors and peers, but find that they cannot commit to set on-campus class times each week. Thus, there have been calls for institutions and educators to provide greater levels of flexibility and choice to students that go beyond the on-campus/online dichotomy (Hill, 2012).

Blended synchronous learning approaches have the potential to answer these calls. For the purposes of this article, we define blended synchronous learning as:

> *Learning and teaching where remote students participate in face-to-face classes by means of rich-media synchronous technologies such as video conferencing, web conferencing, or virtual worlds.*

The mainstreaming of enabling technologies in recent years, fuelled by the growing ubiquity of high-speed broadband Internet connectivity, have made it feasible to 'open up' on-campus activities to off-campus students via the Internet and in some

cases to permit free movement of students between on-site and online participation. This allows all students enrolled in a course to partake in shared, real-time experiences irrespective of their location. Given the emerging interest in this area, the goal of the research reported in this article was to investigate how design and implementation factors influence the nature and quality of blended synchronous learning, through an analysis of seven case studies carried out at Australian universities.

2. Literature Review

2.1. Blended synchronous learning benefits

Owing in part to the relative infancy of the topic, the research base on blended synchronous learning approaches is somewhat sparse. Despite this, what research there is suggests a range of practical, educational, and economic benefits. For example, brick-and-mortar educational institutions stand to gain from having the capacity to take on greater enrolment numbers with the same amount of classroom space at little cost and from being able to expand their reach to new student populations (Rogers, Graham, Rasmussen, Campbell, & Ure, 2003; White, Ramirez, Smith, & Plonowski, 2010). Blended synchronous learning can provide students with greater educational access and, in many ways, offer more inclusive and equitable learning experiences to those who are geographically isolated or cannot physically be in classes (Cunningham, 2014; Norberg, 2012). For instance, it can enable students who cannot be present in person because they are working full time, need to mind children, or are ill to still join in on campus-based classes (Pope, 2010). It can let remote participants experience an instructor's lesson, ask and answer questions, add their own comments to the class dialogue, and generally allow engagement "in a similar manner to on-campus students" (White et al., 2010, p. 35). As a consequence it can provide opportunities for social interaction, peer/teacher support, and knowledge sharing not easily accomplished through asynchronous means (Park & Bonk, 2007; Rogers et al., 2003).

Irvine (2009, 2010; Irvine, Code, & Richards, 2013) proposed a four-tiered model for *'multi-access learning*' aimed at empowering students to customise the way in which they engage with their instructor and peers in a course. The core, underlying principle is one of promoting autonomy in terms of how each student accesses the learning environment through a mixture of F2F delivery, synchronous online learning, asynchronous online learning, and open learning. Blended synchronous learning corresponds to the second tier of Irvine's model, which entails overlaying onto the core of the traditional, F2F classroom (Tier 1) synchronous online access for remote students, enabling those students to take part in activities in real-time along with their classmates who are located on campus. In their pilot study of Tier-2 multi-access learning (i.e., blended synchronous learning), Irvine et al. (2013) found that students liked this type of approach more than traditional F2F, online, and blended approaches, and that most of them viewed having a choice in delivery modes as being 'very important'. Open-ended survey responses revealed that the students perceived multi-access learning as providing a superior (57%) or equal (43%) level of quality when compared to traditional approaches, with no significant difference between the F2F and remote groups.

Though the conventional wisdom is that students prefer in-person, F2F interaction to online communication (where their life constraints allow), some researchers have observed that many students who have the choice of attending blended synchronous classes F2F or remotely opt for the latter for a variety of reasons. Butz, Stupnisky, Peterson, and Majerus (2014) conducted a study in which they surveyed 68 on-campus and 44 online students in masters-level business programs that involved blended synchronous delivery. They compared the two groups of students in terms of motivation, need satisfaction, and perceived success. Their analyses showed that apart from a higher sense of relatedness by on-campus students, there were few significant differences in motivation, needs satisfaction, and perceived success between the two groups, and that both the online group and on-campus group preferred their mode of participation. These results indicate that blended synchronous learning may be able to satisfy various motivational, psychological, and performance needs of students irrespective of their attendance mode, and raises the possibility that online participation may be an active preference rather than a less favoured option.

Convenience is commonly cited as a reason for preferring to remotely participate in blended synchronous learning activities (Irvine, 2010; McCue & Scales, 2007; White et al., 2010), particularly for students who have a demanding life outside their studies (Pope, 2010). According to McCue and Scales (2007), students enrolled in on-campus mode have expressed great satisfaction in being able to choose between attending class live in-person or live online, with the extra benefit of having lectures recorded for later review; Vu and Fadde (2013) have further added that the lecture recordings are more engaging as a result of being recorded in front of an actual class. Some students particularly appreciate being able to unobtrusively contribute to the discussion via text chat (McCue & Scales, 2007; Vu & Fadde, 2013). Interestingly, Park and Bonk (2007) discovered that regardless of whether their students participated remotely or F2F, they adopted similar learning strategies during a blended synchronous session. Evidence from other studies suggests that blended synchronous learning can lead both cohorts of students to attain similar learning outcomes (Szeto, 2014a) and to develop a similar sense of community (Atweh, Shield, & Godat, 2005; Shield, Atweh, & Singh, 2005).

This notion of creating an enhanced sense of community among both F2F and remote students is arguably one of the main educational advantages of blended synchronous learning (Lidstone & Shield, 2010). It has been claimed that participants in blended synchronous learning interventions experience high levels of social presence—a key component of a *community of inquiry* (CoI) (Garrison, Anderson, & Archer, 2000)—and this may partially be attributed to the immediacy that real-time communication offers, coupled with the dynamic and spontaneous nature of the interactions it supports (Cunningham, 2014; Park & Bonk, 2007). Nevertheless, the findings of a number of studies (e.g., Butz et al., 2014; Szeto & Cheng, 2014) seem to indicate that social and emotional connectedness cannot be taken for granted but rather needs to be actively encouraged and fostered by teachers in blended synchronous learning environments.

The heightened sense of community purportedly brought about by blended synchronous learning can also partly stem from the ability to form a larger cohort of students, so that more perspectives can be shared (Cunningham, 2014; Park & Bonk, 2007; Rogers et al., 2003; Szeto, 2014b, 2015; Szeto & Cheng, 2014). Remote

students have avenues through which to forge stronger professional learning relationships with their instructor and peers (Cunningham, 2014), while on-campus students may benefit from the expertise of their external counterparts (Stewart, Harlow, & DeBacco, 2011), who in many cases are older and have substantial industry or life experience to share (McCue & Scales, 2007). Alternatively, some academics have found that blended synchronous learning can be useful to build community in less structured teaching contexts, such as through out-of-class discussion and cooperative learning in graduate and higher degree research classes (Henriksen, Mishra, Greenhow, Cain, & Roseth, 2014; McCue & Scales, 2007; Roseth, Akcaoglu, & Zellner, 2013; Stewart et al., 2011).

2.2. Blended synchronous learning challenges

Despite its tremendous potential, blended synchronous learning is not without its problems and challenges. To begin with, student and teacher preconceptions may pose significant hurdles. As Norberg (2012) has noted, "where there is no technology at all, a teacher has to be in the same room with his or her students to build a learning environment … while those limitations no longer exist technologically, they still exist culturally" (p. 329). The paucity of relevant professional development and training opportunities presents another barrier to the growth of blended synchronous learning (Szeto, 2014b). Lack of institutional recognition for the degree of effort involved and cultures that do not encourage risk taking can leave teachers feeling unsupported in their efforts to innovate in this area (Stewart et al., 2011).

Before commencing teaching with a blended synchronous approach, remote students' technical skills and familiarity with the communication platform are issues that warrant consideration (White et al., 2010). The F2F students, too, need time and help to adjust (Szeto, 2014b, Szeto & Cheng, 2014). Some F2F students have suggested that teachers can become overly focused on remote students, prioritising their queries and spending time troubleshooting their technical problems (Cunningham, 2014; Popov, 2009; Rogers et al., 2003; Szeto, 2014a, 2015). On the other hand, some remote students have complained about being uncomfortable as they feel as if they are being made the centre of attention (Szeto, 2014a, 2014b; Szeto & Cheng, 2014). The technology can also be an imposition for F2F students, for instance if they need to be conscious of the orientation/positioning of cameras or are required to speak into a microphone (Cunningham, 2014; Rogers et al., 2003). Trying to cater to students in both modes at the same time can lead to teachers compromising their pedagogical approaches, such as by 'slide reading' or slowing down their teaching pace (Popov, 2009; Szeto, 2014a, 2014b). Factors like these can leave F2F students feeling blended synchronous delivery negatively impacts upon their learning (Stewart et al., 2011).

These challenges underscore the demands placed on teachers in successfully creating and managing blended synchronous learning environments. Attempting to integrate teaching of F2F and remote students can considerably raise the level of effort required, compared to teaching in a single mode (Norberg, 2012; Popov, 2009). For example, it can be difficult to promote seamless interaction between remote and F2F students (Stewart et al., 2011), and teachers may need to expend additional class time and energy encouraging remote students to contribute as well as stimulating meaningful communication and collaboration between the two groups (Park & Bonk, 2007; Rogers et al., 2003). Such interaction across modalities typically does not occur in a spontaneous fashion (Szeto, 2014a, 2014b, 2015; Szeto & Cheng, 2014) and the

remote students can sometimes feel left out or unwelcome (Cunningham, 2014). It may therefore be necessary to limit student numbers in order for teachers to effectively manage and support the blended synchronous learning experience (White et al., 2010). The importance of maintaining a reasonable student-to-teacher ratio seems even more pronounced in light of Szeto's (2015) finding that teaching presence played a more prominent part than the other two CoI presence types (social and cognitive) in the attainment of the intended learning outcomes in a blended synchronous scenario.

One way to mitigate the load on individual teachers is to employ one or more teaching assistants who can attend to technology-related problems, respond to student text chat comments, and manage other issues not related to the core aspects of the lesson (Bell, Cain, & Sawaya, 2013; Rogers et al., 2003; White et al., 2010). Having multiple teachers involved in class discussions can also lead to a richer learning experience for all students (Lidstone & Shield, 2010). Cunningham (2014) went as far as to recommend remote students not be afforded the same speaking privileges as on-campus students as long as the teacher is alone in the classroom. Vu and Fadde (2013) discovered that permitting backchannel communication among students through a text chat or similar feature has the potential not only to reduce the instructor's burden, but also to foster peer interaction within and across attendance modes. Overall, a recurring theme found in the literature is how vital it is for teachers to be well prepared and organised (Chakraborty & Victor, 2004; Rogers et al., 2003), since blended synchronous teaching invariably entails multitasking and juggling a number of roles (Szeto, 2014b, 2015).

2.3. Blended synchronous learning tools and configurations

An array of technological tools with a range of affordances is available and has been used to facilitate blended synchronous learning. Examples include room-based videoconferencing systems such as those manufactured by Polycom (Chakraborty & Victor, 2004; Okita, 2013); desktop web-conferencing platforms like Skype (Cunningham, 2014); web-conferencing platforms like Blackboard Collaborate (Spann, 2012), Adobe Connect (Butz et al., 2014; Okita, 2013; Park & Bonk, 2007; Vu & Fadde, 2013), and Saba Centra (White et al., 2010); virtual worlds like Second Life (Beltrán Sierra, Gutiérrez, & Garzón-Castro, 2012); chat rooms with video feeds (Lidstone & Shield, 2010); and even custom combinations of Web 2.0 applications like Etherpad, Piazza, Google Hangouts, and Google Forms (Roseth et al., 2013). These tools can be used on standard, Internet-connected desktop or laptop computers, and increasingly, on an assortment of mobile and handheld devices including smartphones and tablet PCs (Cain & Henriksen, 2013; Cain, Sawaya, & Bell, 2013; Cunningham, 2014). On occasions, interactive whiteboards (IWBs) and tablet devices have been used in conjunction with web conferencing to increase the capacity of teachers to annotate slides and draw diagrams (McCue & Scales, 2007).

The ways in which these blended synchronous learning tools are arranged and deployed can vary. Okita (2013) distinguished between *point-to-point* connections where many students at each of two sites are connected by a video feed streamed in each direction and *multipoint* connections between several remote participants, each in a different location, with multiple video feeds streamed in each direction. Hastie, Hung, Chen, and Kinshuk (2010) conceptualised blended synchronous learning configurations in terms of whether teachers and/or students are in the cyber classroom

and/or the physical classroom as well as the number of participants in each location (groups or individuals). Their nine-mode model demonstrates the range of possibilities for blended synchronous learning, from one remote student logging in to a teacher-led small group F2F session, to many teachers and many students at many different locations collaborating via synchronous technologies. Bell, Sawaya, and Cain (2014) characterised four basic topographical structures or layouts that are possible in blended synchronous (which they refer to as *synchromodal*) learning that lend themselves to different course and learning designs: *linked classroom*, *shared portal*, *personal portal*, and *small group*.

In addition to communications structure or design of the class, critical to the success of any blended synchronous lesson is how the chosen system or platform performs in terms of functionality and reliability (Stewart et al., 2011; White et al., 2010). Lags or breaks in audio transmission, for example, can be highly detrimental to the success of blended synchronous learning activities (Chakraborty & Victor, 2004; Okita, 2013; Pope, 2010; White et al., 2010). Student bandwidth is part of this concern, and represents a perennial problem in terms of ensuring uninterrupted communication; this was especially significant in the earlier days of blended synchronous learning (Atweh et al., 2005; Park & Bonk, 2007; Shield et al., 2005). Difficulties with connectivity can lead to teachers choosing low-bandwidth tools such as text chat over more bandwidth-intensive options such as video (Lidstone & Shield, 2010; Vu & Fadde, 2013).

Capturing teacher and students' F2F discussions so that they can be broadcast to remote students, particularly without background noise, is difficult (McCue & Scales, 2007; Park & Bonk, 2007; Rogers et al., 2003). Similarly, capturing video feeds as the teacher moves around the class can also be problematic (White et al., 2010). A degree of adaptation and accommodation is necessary on the part of both teachers and students (Szeto, 2014b; Szeto & Cheng, 2014), yet in attempting to resolve these issues, care must be taken not to excessively modify or constrain F2F lesson activities (White et al., 2010). All of these factors can generate *transactional distance* (Moore, 1993), making students feel isolated, disconnected, and consequently, demotivated.

The extant empirical literature on blended synchronous learning appears to be disconnected and highly contextualised, consisting primarily of 'show-and-tell' accounts that are largely or purely descriptive and that do not include a substantial evaluation component. Few empirical studies to date have systematically examined pedagogical and learning design issues and considerations in blended synchronous scenarios, and those studies have produced limited evidence attesting to the efficacy or otherwise of the adopted approaches. Importantly, recommendations that are evidence-based as opposed to reliant on anecdotal observations and reflections are needed to assist educators in ascertaining what works and what does not, and to supply them with guidance as they design and implement blended synchronous learning lessons and activities for their students. The present research sought to meet this need by conducting a rigorous cross-case analysis of blended synchronous learning across a range of learning designs, subject areas, and technological environments, hence enabling patterns to be observed and principles for practice to be abstracted.

3. Methodology

Case study partners were selected from 1,748 responses to a 2011–2012 survey of Australian and New Zealand tertiary educators on rich-media synchronous technology usage (Bower et al., 2012). Following liaison with a range of potential partners, seven cases were selected for intensive further study and evaluation. Initial shortlisting of the cases was done primarily on the basis of the educators' existing learning and teaching designs as described in their answers to the survey, with final selections being made after informal conversations and subsequent follow-up correspondence with the shortlisted individuals. The central criterion for inclusion was the presence of an existing design in which rich-media synchronous collaboration technology was being used in a thoughtful, purposeful way to solve an identified pedagogical problem. In addition to striving for diversity in the designs, the research team specifically sought blended synchronous learning designs that were relatively mature (defined as having undergone at least two prior iterations or semester offerings). An effort was also made to include cases that represented a variety of technologies, discipline areas, and institutions. Prior to case study observations, the project team worked with the case study partners to reflect upon and in some cases refine the pedagogical and technological aspects of the blended synchronous learning designs. The cases and the numbers of remote and F2F students in each are summarised in Table 1.

Table 1
Summary of cases and participants.

Case no.	Technology	Subject area	Learning activity	F2F students	Remote students
1	Web conferencing	Actuarial studies	Collaborative evaluation of examples of student work	11	7
2	Room-based video conferencing	Health informatics	Lecture and small-group collaboration	24	17
3	Web conferencing	Medical science	Large-group question and answer and small group problem solving	12	11
4	Web conferencing	Statistics	Direct instruction and individual problem solving	12	2
5	Virtual worlds	Chinese studies	Paired role play	12	9
6	Web conferencing	Sexology	Lecture and whole-group discussion	7	15
7	Virtual worlds	Teacher education	Direct instruction, whole-group discussion, and small-group activities	23	22

Note. F2F = Face-to-face.

This project adopted a collective case study methodology, using a standard case study data collection and analysis approach as outlined by Yin (2009). Several sources of data were collected from each case, including: (a) a pre-observation teacher-documented overview of the case as it had been implemented in the past, (b) pre-observation teacher interviews in order to determine the rationale for the designs as well as teachers' insights into the blended synchronous learning approach, (c) video and screen recordings of the blended synchronous learning lessons, (d) researcher observations of the lessons, (e) post-observation student survey responses, (f) post-observation student focus-group interviews, and (g) post-observation teacher interviews. The summary of each of the designs was derived from the pre-observation teacher-documented overviews, the researcher observations of the blended synchronous lessons, and the video and screen recordings of the lessons.

The cross-case analysis method involved reviewing all seven sources of data outlined above and distilling pertinent themes with relation to the presage factors (pre-lesson design), process factors (lesson implementation), and products (effects of design and implementation). The Presage–Process–Product (PPP) model (Biggs, 1989) has previously been used as a framework for conceptualising the design of online learning communities (Brook & Oliver, 2003) and how online educational resources influence outcomes in blended learning environments (Kember, McNaught, Chong, Lam, & Cheng, 2010). Because this model provides a generally accepted and flexible approach to describing lesson design, enactment, and outcomes, it was used in the present study to structure the cross-case analysis.

Analyses for each case were conducted in an iterative way, with data themes emerging within the broad parameters of the PPP model. Multiple analysis 'passes' were made through the data in order to confidently establish themes. Sources were analysed and cross-checked by the team to establish consistency of the concepts of interest in the study. Multiple data sources were also used to triangulate and confirm results within cases, and repeated observation of the main effects across multiple cases strengthened the validity of the study's findings. Conceptual themes appearing in each case were tabulated to facilitate a cross-case comparison. Primary themes emerged, which represented those that were observed across at least two cases.

In reporting on each of the cases below, the researchers' view of the case is first outlined, then it is checked for validity and supplemented by student perceptions (collected via post-lesson survey data and focus-group interviews) and teacher perceptions (from both the pre- and post-lesson interviews). Due to space limitations, only aspects of the case relating to salient and emerging themes have been incorporated. In some instances themes were observed in more cases than reported here, but have not been described in each case for brevity. For more detailed descriptions of each of the cases, please refer to the *Blended Synchronous Learning Handbook* (Bower, Dalgarno, Kennedy, Lee, & Kenney, 2014).

4. Cases

4.1. Case 1: Web conferencing to develop investment understanding

In the first case, remote and F2F actuarial students used the Adobe Connect (http://www.adobe.com/products/adobeconnect) web-conferencing system to complete a review of past examination responses in order to prepare them for their

upcoming investment examination. This was a substantial redesign from previous years, in which the teacher had lectured students about examination technique. Remote and F2F students were randomly assigned to two breakout rooms where they used text chat to discuss the responses and assign marks to each past examination response. The F2F classroom is shown in Fig. 1.

Fig 1. Case 1 F2F room layout with students participating in web-conferencing activities.

Fig. 2 shows the web-conferencing interface used by both remote and F2F participants, including the examination responses from past students, a participant list, a text chat area, two notes areas to document marks that the group would award, a notes area to summarise key points about examination technique, and a file share area.

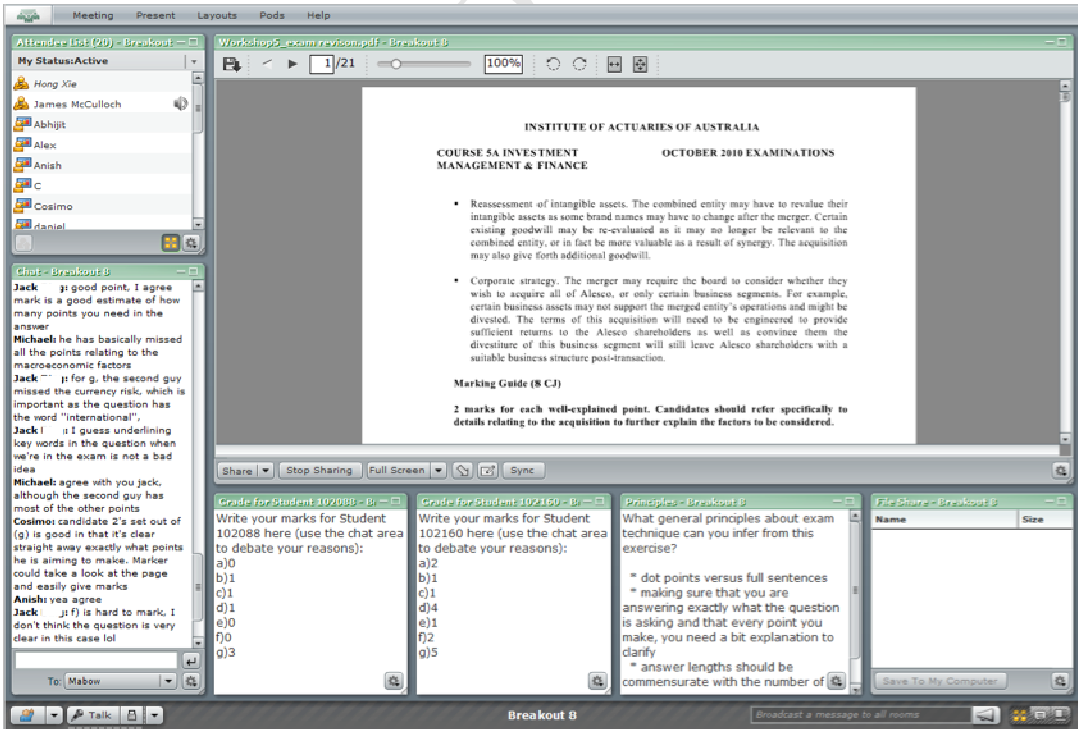

Fig. 2. Case 1 remote student view.

Using the random grouping function of the web-conferencing system made group allocation simple and, as one student put it, “levelled the playing field” for remote

students. However, F2F students commented that it would have been simpler to speak to their co-located peers and that they would have preferred to use audio rather than typing. Some students initially struggled to use the interface—they had not been told in advance how to scroll and zoom and their permissions in the breakout rooms was such that one person's changes affected everyone's view. By circulating among groups the teacher and teaching aid were able to quickly rectify these problems. Having the teaching assistant logged in to a second computer enabled him to field student questions and alert the teacher if there were audio problems. At the end of the lesson, the teacher commented on the responses from each group and encouraged students to ask clarifying questions.

In their feedback, students indicated that the more active learning approach and the greater variety of viewpoints were advantages, though technological issues had interrupted the flow of the lesson. There was at times a duplication of instructions to cater for the two different cohorts, which along with the constraints on verbal communication made some F2F students feel the approach was more valuable for remote students.

The teachers were pleased with the lesson overall. They emphasised the importance of preparing the breakout rooms in advance and starting the session 10 minutes early so that students could test their audio. They also felt that asking questions to promote discussion and using strategies to optimise the use of text chat (e.g., having students prepend the letter 'Q' to distinguish text chat questions from comments) supported more efficient lesson implementation.

4.2. Case 2: Room-based video conferencing to evaluate healthcare approaches

In Case 2, the Access Grid room-based video-conferencing system brought together students on three separate campuses to evaluate patient journey-modelling approaches (for information about Access Grid, see http://www.accessgrid.org). The teacher enlisted technical support from the University's central IT staff to help set up the lesson, including use of the Bridgit conferencing software (http://www.smarttech.com/bridgited) between the three locations. Fig. 3 shows the main classroom with the teacher presenting to both remote and F2F students.

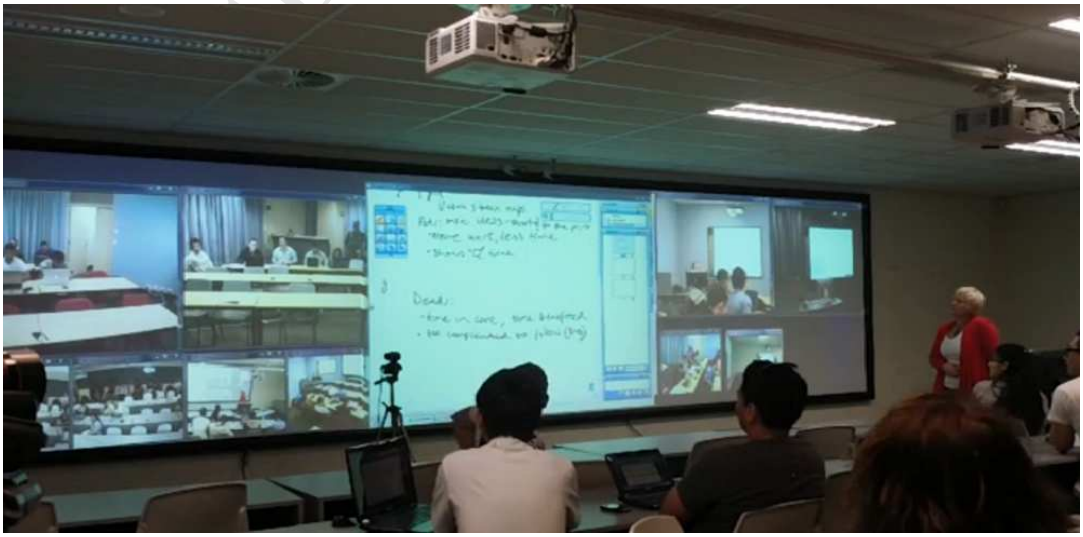

Fig. 3. Case 2 F2F room setup, showing students from multiple campuses and the shared IWB.

At the outset of the lesson, the teacher gave a clear overview lecture of patient journey modelling, during which she repeatedly used humour and questioned students (including those on remote campuses) in order to solicit involvement. Students were then asked to divide themselves into groups of approximately four members with peers in their room, a grouping strategy that simplified communication as opposed to collaborating across campuses. Each group assumed the role of a team of business analysts and was required to critique and report on three patient journey-modelling frameworks. Students engaged enthusiastically with the authentic nature of the task, and the teacher as well as a tutor who was present at one of the remote locations circulated among student groups to provide them with assistance.

One group from each campus then presented their findings to the entire cohort via Access Grid and the networked IWB system. As this was the first time students had used an IWB in class, the teacher supplied in-situ guidance on how to operate it. Remaining groups were encouraged to contribute additional points. The teacher summarised and evaluated student responses.

Student survey and focus-group responses spoke positively about the active learning approach and the strategies used by the teacher to engage students at all campuses. A minority of students (10 out of 41) indicated that the performance of the technology had inhibited communications, complaining, for instance, that "soft microphones restricted verbal communications and being able to hear at times" and that the teacher "needed to repeat herself and students a lot". Some students noted the ability of the video-conferencing system to transparently capture audio and visual contributions enabled more natural communication ("having a normal intuitive means of communication made it seem like they [the students at the other campuses] were not remote at all"). Students appreciated how the IWB facilitated visual communication, though some raised latency as an issue.

Several students highlighted the effectiveness of the strategies used by the teacher to involve all students, and the teacher herself emphasised the importance of being animated. The teacher also noted the importance of flexibility and adaptability, particularly in relation to dealing with technology issues.

4.3. Case 3: Web conferencing to support microscopic tissue analysis

In this lesson, Adobe Connect enabled remote and F2F students to perform an interactive review of medical science (histology) material for an upcoming exam. The teacher was well versed in using the system based on several semesters of prior use, and set up all resources and spaces by herself. Fig. 4 shows a screenshot of one of the web-conferencing activities. The F2F classroom is shown in Fig. 5 with the teacher moving around the class in between operating a desktop computer.

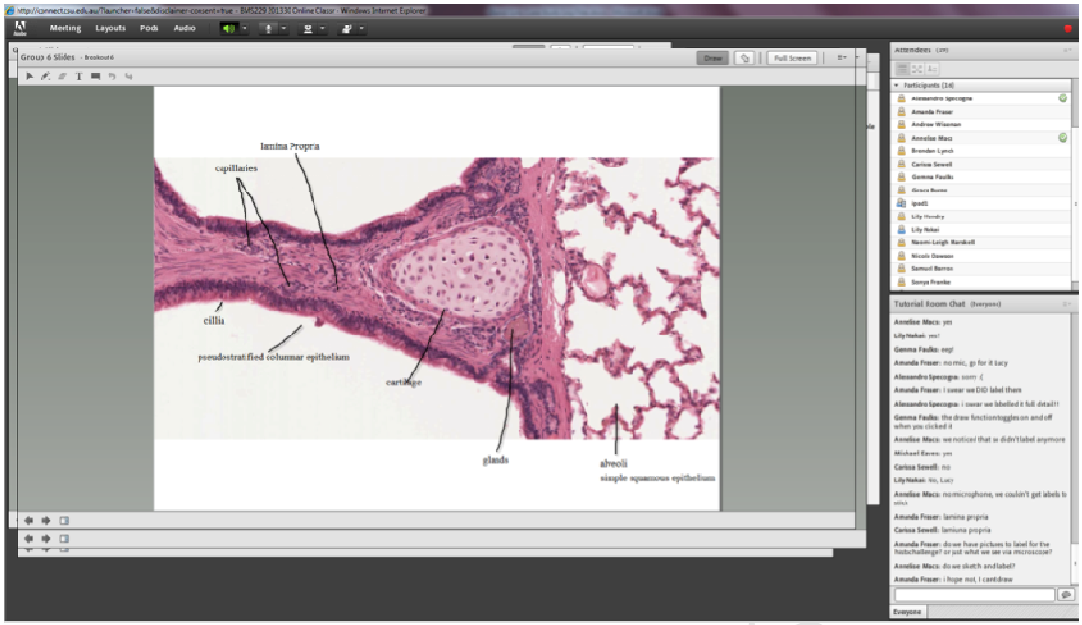

Fig. 4. Case 3 remote student view during a diagram labelling activity.

Fig. 5. Case 3 F2F room setup with students participating in web-conferencing activities.

Prior to commencing the lesson, the teacher welcomed remote participants into the web-conferencing environment to confirm they could hear her audio. During the first part of the lesson students completed a series of multiple-choice and short-answer questions using the polling tools, and the teacher provided tactful explanations about why each answer was correct or incorrect. Both remote and F2F students were encouraged to ask clarifying questions either verbally (on-campus students) or using text chat (remote students). The second part of the lesson involved pairing students to complete diagram-labelling activities. Communication between on-campus students was noticeably smoother, with the absence of an audio channel apparently making it difficult for remote students to coordinate activity since most of them did not have or did not use a microphone. Some technological issues were experienced, including computer crashes and text chat not functioning in one of the breakout rooms, but the teacher and students were able to overcome these.

Student survey and interview feedback was overwhelmingly positive, to a large extent because of the active pedagogies that were employed:

> *This lesson is so much more engaging than your average lecture or tutorial. I find personally I'm more attentive, and the active participation components help the information to sink in more easily.*

The technology was seen to facilitate more effective collaboration for both remote and F2F students through the ability to respond to polls and perform diagram-labelling activities. While some remote students found communicating using text to be constraining, others felt it was a comfortable communication mode that enabled them to experience a strong sense of co-presence with their peers: "we do this every day over social media … everyone feels comfortable in the chat room and it feels like they are in the room with us". Students also appreciated the expedient access to the teacher and peers that text provided, the positive environment that the teacher established, and the broader range of views that could be shared.

The teacher indicated that her preparation, which also included making sure students were prepared for the lesson, was the key to delivering a seamless learning experience. Over time, her approaches had matured to engender more active participation and respond to emerging student needs by "being able to quickly adapt a question or an activity around what might have been asked".

4.4. Case 4: Web conferencing for participation in statistics tutorials

The fourth case involved using Blackboard Collaborate (http://www.blackboardcollaborate.com) web conferencing to allow remote students to take part in F2F statistics tutorials. Through several previous semesters of experience, the teacher had become adept at setting up and managing the environment. She logged in to Collaborate via her tablet computer so she could write statistical notation on her slides and also logged in via a separate laptop to converse with remote students and understand their experience. F2F students did not log in themselves but followed the lesson via the projector screen. Fig. 6 shows the teacher annotating statistics slides for simultaneous viewing by both F2F and remote students.

Fig. 6. Case 4 F2F room setup with teacher annotated slides visible by remote and in-class students.

The teacher skilfully led students through a series of slides that addressed the logic of hypothesis testing, annotating the slides to provide scaffolding and incrementally modelling problem-solving processes. She regularly asked both F2F as well as remote students whether they had any questions and adapted the lesson to respond to their

needs. Students were then provided with extended time periods to solve problems, with F2F students working in small, self-selected groups and remote students working in a breakout room using text chat. The teacher circulated among the remote and F2F groups to help them with the problems. After each problem set the teacher facilitated a whole-class discussion of the solution, during which she sporadically repeated spoken conversation from the F2F classroom into the microphone so that remote students could hear.

Student feedback responses raised the lack of collaboration between the two cohorts, though neither cohort appeared overly concerned about this. The main issue appeared to be remote students not being able to hear students in the F2F class. Also, some F2F students felt that the blended synchronous learning mode may have reduced the amount of teacher time they received.

Several students commented on how the teacher's competence at using the technology contributed to the quality of the lesson, and the value of the active learning approach was also acknowledged. Moreover, feedback highlighted the value of the approach in terms of equality of access and flexibility:

> *I'm an internal student and was unable to attend a tutorial one day as my kids were sick so I did it online*

The teacher considered that careful preparation of the lesson according to desired learning outcomes was vital:

> *thinking very carefully about what you want the students to experience, or get out of this tutorial … which is really developing techniques, developing skills, being well prepared, … leads to better outcomes*

At the same time, she acknowledged that remote student voice functionality and better capture of F2F student audio would have increased the ability of the two cohorts to interact with each other.

4.5. Case 5: Virtual worlds to facilitate Chinese language learning

In the fifth case, students participated in a tightly constructed role-play activity in Second Life (http://www.secondlife.com) to develop their Mandarin language capabilities. The teacher had developed 'Chinese Island' over several semesters for the purpose of facilitating task-based language learning activities in the virtual world. Students could either participate from on-campus computer laboratories or from external locations. A screenshot of a student desktop is shown in Fig. 7.

Fig. 7. Screenshot of student desktop from Case 5 showing the virtual world, video and text communication tools, and language reference material.

The objective of the lesson was for students to interact with automated non-player characters (NPCs) and with their partners in the virtual world environment in order to obtain directions to a market, purchase ingredients, and then return to a restaurant kitchen to make a bowl of soup dumplings. Remote students were paired with F2F students, which took some time to organise but meant that F2F students could relay information to their remote partners if required. Students in each pair communicated with each other via voice and text in a combination of English and Chinese, and with the NPCs via Chinese character text chat. Because the task and environment were so comprehensively designed, the teacher was able to spend most of his time providing one-on-one subject matter and technology support to students.

Some students experienced temporary technical failures, including loss of audio and unexpectedly being logged out of the virtual world. Text chat was used to work around intermittent audio problems. Other students had some difficulty navigating around the environment. Yet, many were able to see past the technology issues to appreciate how the authentic activity contributed to a richer learning experience:

> *when I did Japanese before … it's just like you're doing an exercise online and that's it, but this … it's actually kind of a real life* [sic]*, and you can get to talk to people and finish the tasks together, but not by yourself, and so like, you apply all those sentence structures, all that vocab*

The teacher expressed how simultaneously facilitating interactions in the physical and in-world settings was challenging, and addressed this by defining the virtual world as the focus environment. The spatial nature of sound in the virtual world proposed another teaching challenge because audio could not be used to speak to people across the entire virtual world. Thus text was often used to reach the whole class at once. The teacher acknowledged how using the virtual environment could impose a time overhead on the lesson, which meant he needed to clearly identify his learning goals. It also meant he had to be well organised and make sure students were prepared. Flexibility and adaptability were seen as crucial when teaching in this mode, in order to accommodate unforeseen circumstances.

4.6. Case 6: Web conferencing to enable presence in sexology classes

This case involved the teacher holding an interactive lecture discussion with sexology students using Blackboard Collaborate. Remote students were encouraged to use audio and headsets, and most logged in to the system before the lesson in order to test their technology setup. Students in the classroom were supplied with iPads so they could better see and contribute to the online discussions. Fig. 8 shows the teacher presenting in the F2F classroom, with slides and webcam showing in the web-conferencing environment.

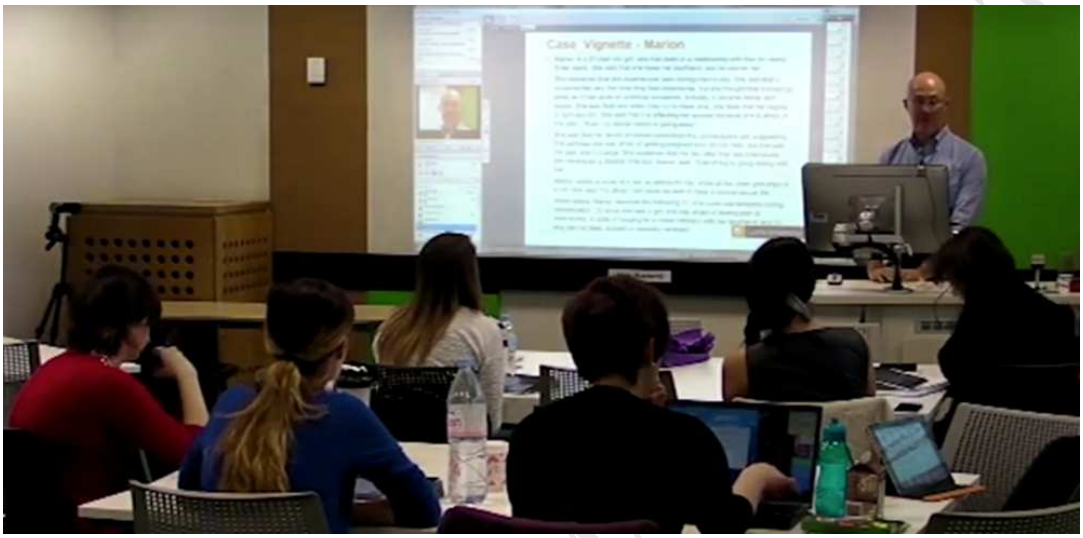

Fig. 8. Case 6 F2F room setup showing the slides and webcam of the teacher projected on the screen behind him.

The teacher presented content on the topic being addressed (sexual dysfunction) but frequently opened up discussion so students could share their views. On-campus student comments could generally be heard by remote students through the web-conferencing system, and remote students contributed to the discussion primarily using text chat. A whiteboard graphing activity and a vignette/case-analysis discussion were included to increase student engagement, though F2F students were not able to participate in the graphing activity because the iPads did not support drawing on the web-conferencing whiteboard. The teacher used a supportive tone, casual language, and humour to foster a safe and welcoming classroom atmosphere.

Students identified several advantages of the blended synchronous learning approach, including the ability to benefit from a broader range of experiences, the ability to attend flexibly, greater capacity to contribute, and a more engaging experience generally. Suggestions for improvement included better integration of remote student text chat discussions with the in-class audio discussions so that there would be less overlap. One student suggested the teacher try to alleviate this by requesting only text or audio comments at any given time. Another on-campus student remarked that the repetition of the F2F conversation by the teacher for the benefit of the remote students could compromise the on-campus class experience.

Students reported a strong sense of co-presence between remote and F2F participants, which they signalled was largely due to the safe environment the teacher created as well as the sense of community and rapport that had been established during previous on-campus residential days that students from both modes physically attended.

The teacher felt that broadcasting his webcam was important because it offered "a greater ability to connect to the students". He believed the load on teachers teaching in this mode amounted to more than either F2F or distance alone, and would have preferred to have the help of a teaching assistant. The teacher also felt the approach required a degree of "letting go". For instance, at first he was not comfortable with students exchanging text chat comments while he was presenting, whereas later he saw this as a valuable feature of the blended synchronous approach.

4.7. Case 7: Virtual worlds for teacher education

In the final case, the AvayaLive Engage (http://engage.avayalive.com/Engage) virtual world platform was used to create a 'blended reality' (Bower, Cram, & Groom, 2010) learning and teaching environment. Students in the F2F classroom could see and hear remote students' avatars via a projection of the virtual world (Fig. 9), and remote students could see and hear their F2F peers via a video stream into that virtual environment (Fig. 10). The approach was used in a second-year educational technology subject for pre-service teachers, to help them understand how virtual worlds could be used to enable new forms of interaction and participation. Prior to the lesson, students were asked to complete a virtual world treasure hunt activity targeted at developing the technological skills they would need for the lesson.

Fig. 9. Case 7 F2F student view showing in-class participants interacting with avatars in the virtual world.

Fig. 10. Case 7 remote student view including a video stream of the F2F classroom.

The lesson incorporated teacher presentations and voting activities in which students indicated their views and preferences with regard to virtual worlds by positioning themselves (in the case of the F2F participants) or their avatars (in the case of the virtual participants) along a line in the F2F and virtual classrooms, respectively. There were also small-group learning design and evaluation tasks that were conducted in breakout spaces for virtual world attendees and around tables for in-class students. The teacher circulated among the on-campus and virtual world groups to help them with the tasks as well as with any technical issues that arose, and he placed time restrictions on each task in order to encourage productivity.

Student feedback showed there were advantages to having remote and F2F students come together using the blended reality approach, including heightened engagement, improved access, and co-presence for remote students; increased willingness of shy individuals to participate remotely; and access to the affordances of virtual worlds. One remotely located student explained her sense of co-presence as follows:

> *I felt like I was engaged in* [the activity] *and felt like I was in the classroom. I was there—that was me. I wasn't just like a little character on the screen; that was me.*

Network and system issues affected the quality of the student experience, particularly for remote students, who often experienced poor audio quality. The teacher's computer also crashed several times, resulting in his losing presence in the virtual world and compromising the F2F student experience while he restarted his machine. Some remote students also reported a sense of isolation from their F2F peers because they were not completing group work with them.

The teacher reflected that a high level of preparation was required to think through the design of activities, set up the rooms (both physical and virtual), anticipate how to facilitate group work and interaction, and pre-empt student problems. Attempting to offer an equivalent experience to both cohorts, avoiding repetition, understanding the student view, and providing technical guidance to students were issues that both demanded significant attention and imposed high levels of cognitive load during the lesson. Institutional support was critical for setting up the technical aspects in advance.

5. Cross-case analysis

5.1. Combined quantitative summary

Table 2 reports aggregate responses to selected survey items from students across all of the cases. The table should be interpreted with caution because as has already been established, the seven cases of blended synchronous learning were by no means homogenous, and there were differences in the numbers of respondents for each case. Nevertheless, Table 2 does serve to demonstrate general trends across the cases.

Table 2
Student responses to key survey items for all cases combined.

Item	F2F (n = 66)			Remote (n = 62)		
In this lesson I felt like I was present with people who were participating remotely.	Agree 73.8%	Neutral 9.2%	Disagree 16.9%	Agree 75.9%	Neutral 13.8%	Disagree 10.3%
In this lesson I felt like I was present with people who were in the same room as the teacher.	Agree 83.3%	Neutral 13.3%	Disagree 3.3%	Agree 60.7%	Neutral 18.0%	Disagree 21.3%
The collaborative technology provided clear and accurate representation of information and people.	Agree 84.6%	Neutral 12.3%	Disagree 3.1%	Agree 80.6%	Neutral 11.3%	Disagree 8.1%
I learnt _____ in this lesson than if the lesson had run in a normal / F2F mode.	More 53.0%	Same 36.4%	Less 10.6%	More 25.8%	Same 50.0%	Less 24.2%
I would like this sort of approach to be used in other subjects that I study.	Agree 73.8%	Neutral 18.5%	Disagree 7.7%	Agree 77.4%	Neutral 11.3%	Disagree 11.3%

Note. F2F = Face-to-face.

Approximately 75% of both remote and F2F students felt a sense of co-presence with classmates attending remotely. In contrast, well over 80% of F2F students felt co-present with other people in the F2F classroom, as compared with just over 60% of remote students who felt co-present with the F2F class. This is by and large reflective of the way in which the technology could at times constrain the flow of information from the F2F class to remote students (e.g., the teacher needing to repeat F2F student comments for them to be heard by remote students, or remote student bandwidth issues causing lags and delays). Even so and in spite of the technical difficulties experienced across the cases, over 80% of remote and F2F students felt the technology was generally able to provide a clear and accurate representation of people and information.

It can be seen from Table 2 that approximately 75% of both remote and F2F students would like the blended synchronous learning approach to be used in other subjects they studied, with only about 10% in each attendance mode disagreeing. Table 2 also shows that 53% of F2F students felt they learnt more through blended synchronous learning than in normal F2F classes, with only 11% saying they learnt less. This indicates that across the cases, blended synchronous learning was generally seen to be more likely to increase the quality of learning for F2F students rather than diminish it. On the other hand, around one quarter of remote students felt they learnt more than in F2F mode and one quarter of them felt they did not. Thus remote students perceived

that blended synchronous learning could achieve an equivalent quality of learning experience as traditional F2F classes (or even exceed it) in some cases.

Remote students were not asked whether the blended synchronous learning approach resulted in them learning more than regular online classes, so it is not possible to determine their perceptions on this issue. However, given that more than 75% of remote students indicated they would like to see the approach employed in other subjects, it is possible that the majority of them feel they learn more in blended synchronous mode than in regular online mode. Further research is required to determine if this is case.

5.2. Presage (design) factors

5.2.1. Pedagogical aspects

A central emergent theme from student and teacher observations across all seven blended synchronous learning cases was the importance of designing for active learning. Examples of this included incorporation of notes areas for students to write solutions (Case 1, Case 2) or using multiple-choice and labelling tasks to stimulate learning conversations (Case 3). Because of the overheads that collaboration sometimes imposed when teaching in blended synchronous environments, teachers emphasised the importance of ensuring learning tasks were accurately aimed toward students achieving the necessary lesson learning outcomes (Case 4, Case 5).

Grouping strategies emerged as another important design consideration in blended synchronous learning settings. Grouping remote students with F2F students could "level the playing field" to some extent (Case 1), enable F2F students to help remote students (Case 5), avoid a fractured sense of community (Case 7), and be more easily implemented through random grouping features of some systems (Case 1). However, grouping F2F students together and remote students together means that the F2F students can communicate more naturally (Case 2, Case 3, Case 4).

Teachers and researchers concurred on the importance of applying general pedagogical design principles in blended synchronous learning environments, such as incrementally scaffolding and modelling new skills (Case 4) as well as setting authentic tasks that students would find intrinsically motivating (Case 2, Case 5).

5.2.2. Technological aspects

It was important to match tools and technologies to the lesson requirements in each case so that participants could effectively represent and share their understanding. Examples included using whiteboards to have students complete labelling and drawing exercises (Case 3, Case 6), and using virtual worlds to facilitate role-play activities (Case 5). Not providing the necessary technology could prohibit effective communication and thus constrain participation, for instance by only allowing students to contribute via text chat instead of audio (Case 1, Case 4). Teachers also emphasised the critical importance of setting up and testing the technology in advance of the lesson (Case 2, Case 6, Case 7).

5.2.3. Logistical/setup-related aspects

There was general consensus among the teachers about the need to be highly organised for blended synchronous learning lessons (Case 1, Case 3, Case 4, Case 5, Case 7). This was mainly due to the complexity of catering for both cohorts and the

perceived risk of not having all resources and the environment available and correctly configured during lesson implementation. Students, teachers, and the research team also noted the benefits of being well practiced with the learning technology (Case 3, Case 4, Case 5, Case 6) and the value of having institutional support to help set up the blended synchronous learning environment (Case 2, Case 6, Case 7).

It was evidently necessary to prepare students with the relevant collaborative competencies for the blended synchronous learning lessons. Being practiced in the technologies meant that students were able to focus on the subject matter of the lesson (Case 3, Case 6, Case 7), whereas not having the required skills could inadvertently interrupt lesson flow (Case 1). Also, having students form a sense of community before a lesson, for instance via a block residential or other on-campus learning activities, could mean they feel a greater sense of connectedness and are more willing to collaborate during a lesson (Case 3, Case 6).

5.3. Process (implementation) factors

5.3.1. Pedagogical aspects

Teachers noted the importance of encouraging regular student contributions during blended synchronous learning lessons so that both cohorts remained engaged. This could be achieved through prompting for responses to questions (Case 1), direct questioning of individuals (Case 2), and presenting in an animated and humorous manner (Case 2, Case 6). Teachers and students also commented on the need to distribute attention between remote and F2F students to avoid a sense of inequity (Case 1, Case 2, Case 3, Case 4, Case 7). This was accomplished in some cases by virtue of the teacher circulating among both the F2F and remote groups (Case 2, Case 4, Case 5, Case 7).

In blended synchronous learning environments, the teacher needs to simultaneously communicate with two cohorts of students. This can sometimes mean two different sets of instructions are required, causing unnecessary repetition for students (observed in Case 2, Case 6, and Case 7). Writing out task instructions and making them available in advance of the lesson is one way to avoid this (Case 5). Often communication is occurring through multiple communication channels, including, for instance, presentation slides, audio, and text chat. This can result in a disjointed learning experience for students unless the teacher identifies where the focus of attention should lie (Case 5, Case 6).

Transferring regular pedagogical strategies from traditional classrooms often contributed to the quality of the blended synchronous learning experience, for example by providing clear explanations of concepts (Case 2, Case 4), sensitively responding to student questions (Case 3), regularly checking for student understanding (Case 4), tightly structuring the timing of activities (Case 7), and using tone and casual language to establish a positive learning environment (Case 6).

Flexibility and composure was also seen as an important teaching attribute, for instance when technical failures occurred (Case 2, Case 3, Case 5, Case 7). The ability and confidence to adapt the lesson to emergent lines of student inquiry enabled the lesson to cater more accurately to learner needs (Case 3, Case 4).

5.3.2. Technological aspects

Technological know-how allowed teachers to provide a more seamless learning experience (Case 3, Case 4, Case 5) and troubleshoot technology problems as they arose (Case 1, Case 3, Case 7). In terms of communication, audio let students make more rapid, extensive, and natural contributions in a way that enhanced the sense of co-presence (as inferred by student comments across Case 1, Case 2, and Case 3). Text chat, on the other hand, was generally more reliable (as observed in Case 5) and allowed multiple simultaneous non-interfering contributions. It was also critical for students to be given appropriate, sound advice and guidance on how best to leverage the technology to support their learning (Case 1, Case 7) as well as for them to have the correct permissions to operate the environment. Having too many privileges may have allowed students to inadvertently disrupt the lesson materials (Case 1), while not having enough permissions could have restricted their ability to contribute (Case 6). Tablet devices offered the potential to facilitate more effective visual input into the environment (as demonstrated through markup of presentation slides in Case 4, though this did not work during student attempts in Case 6).

5.3.3. Logistical/setup-related aspects

Teachers recommended a range of practical strategies and tactics to help manage the challenges of implementing blended synchronous learning lessons. For instance, starting lessons at least 10 minutes before the scheduled time enabled them to test that the technology was working and students to do the same (Case 1, Case 3, Case 6). Logging in to a second computer 'as a student' allowed teachers to better appreciate the student view, including any technological problems that might have been occurring (Case 1, Case 4). Teachers also noted strategies for working with text chat contributions, examples of which were asking students to prepend the letter 'Q' to questions for easy identification within the text chat stream (Case 1) and encouraging students to respond to one another if the teacher was otherwise occupied (Case 6).

5.4. Product (outcomes) of the blended synchronous learning environments

5.4.1. More active learning (remote and F2F)

Both remote and F2F students across the cases indicated that they appreciated the more active learning approaches afforded by blended synchronous learning. Being able to participate in classes through question-and-answer sessions, diagram-labelling tasks, collaborative evaluation activities, role plays, whiteboard exercises, and design exercises meant students were able to apply the knowledge they were learning. This could, in turn, lead to more effective learning, as indicated by the Case 3 student comment "the active participation components help the information to sink in more easily". This accords with results reported by White (2010), and is reinforced by the fact that 89.4% of F2F survey respondents (from n = 66) and 75.8% of remote survey respondents (from n = 62) felt they learnt as much or more in their blended synchronous learning class when compared to regular F2F classes.

5.4.2. Enhanced sense of co-presence and community

In most instances, blended synchronous learning enabled remote and F2F students to feel a sense of co-presence with one another. Of the 66 F2F students who responded to the lesson evaluation survey, the majority (73.8%) felt present with remote students; 60.7% of the 62 remote student respondents felt present with people in the F2F class. It should be noted that sense of co-presence varied widely between cases, with student open-ended survey responses indicating that the sense of co-presence

depended on the technology performance and on human factors. Across the cases, uninterrupted audio and video feeds from the F2F classroom were noted as contributing to the remote student sense of co-presence, just as remote student use of audio and video contributed to the F2F student sense of co-presence. Human factors that influenced the sense of co-presence included prior F2F contact with remote students (Case 6), tone and humour (Case 2, Case 6), as well as individual comfort level with the collaborative technologies (Case 3). Qualitative feedback suggested the blended synchronous learning mode could improve the sense of class community (Case 6). The potential for enhanced sense of community between remote and F2F students echoes the findings of previous research into blended synchronous learning (Atweh et al., 2005; Lidstone & Shield, 2010; Shield et al., 2005), though the need for deliberate strategies to bring that potential to fruition also aligns with previous studies (e.g., Butz et al., 2014; Szeto & Cheng, 2014).

5.4.3. More flexible access to learning

Remote students from across all cases invariably appreciated that they could participate in live classes from their homes or workplaces, and in some cases indicated this increased their capacity to attend. F2F students also identified the benefits they derived from having remote students flexibly access lessons, in terms of being exposed to a broader range of views and ideas (Case 3). Blended synchronous learning could additionally offer F2F students flexibility if they were unable to get to classes in person, like the Case 4 internal student who attended a tutorial remotely one week as she could not be on-campus because her children were ill. This favourable perception of increased access to learning is, again, in agreement with previous work on blended synchronous learning (Cunningham, 2014; Norberg, 2012; Pope, 2010).

5.4.4. Increased student satisfaction

Responses to the lesson evaluation surveys across the seven cases indicated that 73.8% of F2F and 77.4% of remote students would like blended synchronous learning to be implemented in other subjects that they studied. Reasons for wanting blended synchronous learning generally related to the more active learning, the flexibility of access, and the enhanced sense of community. There were some students (7.7% of F2F students and 11.3% of remote students) who indicated they would not like blended synchronous learning to be used in other classes, typically citing a preference for F2F lectures or subject inapplicability. On the whole, the results are a strong indicator that blended synchronous learning enhanced the student learning experience and resonate with findings by Irvine et al. (2013), who reported superior or equal student satisfaction with blended synchronous learning vis-à-vis traditional approaches.

5.5. A Blended Synchronous Learning Design Framework

The cross-case analysis of the seven blended synchronous learning cases led to the development of the Blended Synchronous Learning Design Framework presented in Table 3. It is based upon the synthesis of student, teacher, and researcher observations across all seven cases.

Table 3
The Blended Synchronous Learning Design Framework.

Presage (Design)	*Pedagogy* • Clearly define learning outcomes • Design for active learning • Determine whether to group remote with F2F students • Utilise general design principles	*Technology* • Match technologies to lesson requirements • Set up and test the technology in advance	*Logistics/setup* • Be highly organised in advance • Solicit the right institutional support • Prepare students • Prepare self • Establish a learning community
Process (Implementation)	*Pedagogy* • Encourage regular student contribution • Distribute attention between remote and F2F students • Identify the focus of learning and discussion • Avoid duplication of explanations • Circulate among groups • Draw upon existing pedagogical knowledge • Be flexible, adaptive, and composed	*Technology* • Know how to use (and troubleshoot) the technologies • Appropriately utilise audio/visual modalities • Advise students on how to use the technology • Ensure students have correct permissions • Use tablet or other mobile/handheld devices to facilitate visual input if required	*Logistics/setup* • Start lessons 10 minutes early for technology testing • Log in to a second computer (to see student view) • Apply tactics to work with text chat contributions • Seek teaching assistance where possible and desirable
Product (Outcomes)	• More active learning (remote and F2F) • Enhanced sense of community (through co-presence) • More flexible access to learning LEADS TO • Increased student satisfaction		

Note. F2F = Face-to-face.

In devising this framework, we have made a deliberate attempt to remain both pedagogically agnostic and technologically neutral, and our efforts to this end have been strengthened by the diversity of contexts, disciplines, tools/platforms, and learning designs present within the examples in which the framework is grounded. Refraining from assuming or favouring particular approaches to learning and teaching as well as resisting the temptation to pre-empt students' and teachers' specific hardware and software choices, we allowed the framework to emerge from cases where a variety of pedagogies and synchronous tools had been applied so as to maximise its transferability to other scenarios.

Clearly, ongoing work could be performed to further validate and refine the framework as well as to develop supporting resources aimed at guiding and assisting educators in its use. Over time, other in-depth studies of blended synchronous learning may give rise to the revelation of new effects, lead to greater understanding of the effects that are known, and potentially even challenge some of those that have been reported here. We do not claim that blended synchronous learning is without its issues (as observed in the cases and elaborated upon in the next section). Yet, the fact that a large majority of students across the cases expressed a preference for blended

synchronous learning highlights the perceived value of this emerging learning and teaching mode.

6. Discussion and conclusion

Across the cases, the blended synchronous learning designs resulted in more active learning. The large majority of both F2F and remote students believed they learnt at least as much, if not more, in the blended synchronous learning class as compared to their regular F2F classes. The majority of both remote and F2F survey respondents felt a sense of co-presence with their alternately located peers, and qualitative feedback indicated students often felt a greater sense of community as a result of the blended synchronous mode. Remote students overwhelmingly appreciated the flexibility afforded by blended synchronous learning, and F2F students also saw how they benefited from the wider range of perspectives being shared. Across the seven cases, approximately three quarters of remote and F2F students wanted blended synchronous learning to be included in their other classes, providing a degree of validation for using the approach.

However, there are a number of significant issues that warrant consideration when teaching in blended synchronous learning mode. One important theme that emerged across a number of cases was the apparent heightened levels of cognitive load that were incurred by teachers and students in blended synchronous learning environments. Teachers not only needed to teach the F2F class and the remote class at the same time, but also had to operate the online technology and facilitate interaction between the two cohorts. Some students also were of the view that learning via blended synchronous mode could result in information overload, though other students found the multiple channels of information kept them engaged and interested. Strategies for managing cognitive load that were exhibited within the cases included directing communication to one particular mode (e.g., audio or text chat) or having students help monitor the text chat. The finding that blended synchronous learning places increased demands on the teacher is in concurrence with results from other studies (Norberg, 2012; Popov, 2009).

Interview data suggested some F2F students felt there was potential for their own learning experience to be compromised in blended synchronous learning contexts. Reasons given for this included the delays in communication in order to accommodate remote students (e.g., by repeating comments from in-class students), the teacher being distracted by the presence of remote students, or the requirement to work in groups with remote students and consequently having to communicate through the software rather than F2F. Although this effect has also been reported in previous studies (Popov, 2009; Rogers et al., 2003; White et al., 2010), it is important to note that only some of the F2F students in the present study had this perception, while others were much more positive about the inclusion of remote students through blended synchronous learning methods. Strategies to promote equity of experience included deliberately distributing attention between remote and F2F participants, encouraging regular contribution from both cohorts, clearly identifying the focus of learning and discussion, avoiding duplication of explanations, and circulating among both remote and F2F groups during small-group activities.

Technology reliability and performance issues with varying degrees of impact occurred in all seven cases. A major technology challenge in a number of cases related to audio within the F2F classroom, with appropriate room-based microphones to receive F2F student comments and appropriate speakers to play the audio from remote students in the classroom often not being available. This regularly forced the teacher to repeat or paraphrase comments, leading to potential information loss and/or a reduction in the sense of virtual co-presence. Other less common technology issues witnessed in some cases included IWB latency, breakout rooms not functioning, students losing access to online spaces, slides not progressing, software crashing, and audio feedback loops. The critical impact of technology performance on blended synchronous learning activities as evidenced in this study concurs yet again with findings from previous studies (Chakraborty & Victor, 2004; Pope, 2010; Stewart et al., 2011; White et al., 2010).

Most existing blended synchronous learning initiatives have been or are being driven by individual academics as opposed to being supported at an institutional level, which has implications for the long-term impact and sustainability of those initiatives. Some authors (e.g., Szeto, 2014b; Szeto & Cheng, 2014) make the point that when adopting blended synchronous learning, teachers need time for boundary negotiation and adaptation of strategies, and students need space and time for practice so as to become comfortable and familiar with the approach. Teaching support has also been highlighted as a critical issue in some studies (Bell et al., 2013; Rogers et al., 2003; White et al., 2010). If institutions are to reap maximum benefit from blended synchronous learning, including more flexible access to programs, improved quality of learning experiences, and enhanced sense of connectedness, they will need to provide teachers with appropriate supports: technical help, teaching assistance, professional development, automated teaching spaces, and preparation time.

Enabling remote students to participate in F2F classes using rich-media technologies constitutes a fundamental alteration to the prevalent delivery model in education. This raises some interesting questions. Does the successful implementation of blended synchronous learning necessitate pedagogical transformation—or at least call for a shift in the mindsets of teachers and students? Does the process of moving to blended synchronous delivery lead, challenge, or otherwise open the door for teachers to rethink, more broadly, the way in which they conceive of and approach the act of teaching, their role, and the role of students (e.g., prompting them to become more student centred, interactive, and so on)? As is often the case, technology may be a catalyst for improved or enhanced learning rather than the cause of it. Further studies examining the epistemological and pedagogical impacts of blended synchronous learning on teaching practice across a broad range of contexts are needed to address these questions.

The seven blended synchronous learning cases examined in this study highlighted the importance of designing for active learning, selecting technologies according to representational and communication requirements, as well as preparing the environment and people for blended synchronous learning activity. Ideally in the years to come, rich-media collaborative technologies will become so invisible that students and teachers interacting from different locations will feel as though they are in the same room. In the meantime, present technologies continue to carry with them significant challenges in blended synchronous contexts, thus requiring teachers to

carefully reflect on their designs and to apply pedagogical strategies and workarounds in order to maximise learning, community building, and the student experience. This investigation provides an evidential foundation to guide the design, implementation, and future research of blended synchronous learning environments.

7. References

Atweh, B., Shield, P., & Godat, M. (2005). The bumpy road of collaborative innovation in online delivery: How to negotiate it? In *Proceedings of the Online Learning and Teaching Conference* (pp. 10–18). Brisbane, Australia: Queensland University of Technology.

Bell, J., Cain, W., & Sawaya, S. (2013). Introducing the role of technology navigator in a synchromodal learning environment. In J. Herrington, A. Couros, & V. Irvine (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2013* (pp. 1629–1634). Chesapeake, VA: Association for the Advancement of Computing in Education.

Bell, J., Sawaya, S., & Cain, W. (2014). Synchromodal classes: Designing for shared learning experiences between F2F and online students. *International Journal of Designs for Learning, 5*(1). Retrieved from http://scholarworks.iu.edu/journals/index.php/ijdl

Beltrán Sierra, L. M., Gutiérrez, R. S., & Garzón-Castro, C. L. (2012). Second Life as a support element for learning electronic related subjects: A real case. *Computers & Education, 58*, 291-302. doi:10.1016/j.compedu.2011.07.019

Biggs, J. B. (1989). Approaches to the enhancement of tertiary teaching. *Higher Education Research and Development, 8*, 7–25. doi:10.1080/0729436890080102

Bower, M., Cram, A., & Groom, D. (2010). Blended reality: Issues and potentials in combining virtual worlds and F2F classes. In C. H. Steel, M. J. Keppell, P. Gerbic, & S. Housego (Eds.), *Proceedings of the 27th ASCILITE Conference* (pp. 129–140). Brisbane, Australia: The University of Queensland.

Bower, M., Kennedy, G. E., Dalgarno, B., Lee, M. J. W., & Kenney, J. (2014). *Blended synchronous learning: A handbook for educators*. Retrieved from http://blendsync.org/handbook/

Bower, M., Kennedy, G. E., Dalgarno, B., Lee, M. J. W., Kenney, J., & de Barba, P. (2012). Use of media-rich real-time collaboration tools for learning and teaching in Australian and New Zealand universities. In M. Brown, M. Hartnett, & T. Stewart (Eds.), *Proceedings of the 29th ASCILITE Conference* (pp. 133–144). Wellington, New Zealand: Massey University.

Brook, C., & Oliver, R. (2003). Online learning communities: Investigating a design framework. *Australian Journal of Educational Technology, 19*, 139–160.

Butz, N. T., Stupnisky, R. H., Peterson, E. S., & Majerus, M. M. (2014). Motivation in synchronous hybrid graduate business programs: A self-determination approach to contrasting online and on-campus students. *MERLOT Journal of Online Learning and Teaching, 10*(2). Retrieved from http://jolt.merlot.org

Cain, W., & Henriksen, D. (2013). Pedagogy and situational creativity in synchronous hybrid learning: Descriptions of three models. In R. McBride & M. Searson (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2013* (pp. 291–297). Chesapeake, VA: Association for the Advancement of Computing in Education.

Cain, W., Sawaya, S., & Bell, J. (2013). Innovating the hybrid small group model in a synchromodal learning environment. In J. Herrington, A. Couros, & V. Irvine (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2013* (pp. 1333–1339). Chesapeake, VA: Association for the Advancement of Computing in Education.

Chakraborty, M., & Victor, S. (2004). Do's and don'ts of simultaneous instruction to on-campus and distance students via videoconferencing. *Journal of Library Administration, 41*, 97–112. doi:10.1300/J111v41n01_09

Cunningham, U. (2014). Teaching the disembodied: Othering and activity systems in a blended synchronous learning situation. *The International Review of Research in Open and Distance Learning, 15*(6). Retrieved from http://www.irrodl.org

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education, 2*, 87–105. doi:10.1016/S1096-7516(00)00016-6

Gosper, M., Green, D., McNeill, M., Phillips, R., Preston, G., & Woo, K. (2008). *The impact of web-based lecture technologies on current and future practices in learning and teaching*. Sydney, Australia: Australian Learning and Teaching Council.

Hastie, M., Hung, I.-C., Chen, N.-S., & Kinshuk (2010). A blended synchronous learning model for educational international collaboration. *Innovations in Education and Teaching International, 47*, 9–24. doi:10.1080/14703290903525812

Henriksen, D., Mishra, P., Greenhow, C., Cain, W., & Roseth, C. (2014, July/August). A tale of two courses: Innovation in the hybrid/online doctoral program at Michigan State University. *TechTrends, 58*(4), 45–53. doi: 10.1007/s11528-014-0768-z

Hill, P. (2012, November/December). Online educational delivery models: A descriptive view. *EDUCAUSE Review, 47*(6), 84–97.

Irvine, V. (2009). The emergence of choice in 'multi-access' learning environments: Transferring locus of control of course access to the learner. In G. Siemens & C. Fulford (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2009* (pp. 746–752). Chesapeake, VA: Association for the Advancement of Computing in Education.

Irvine, V. (2010). Exploring learner needs for collaboration and access. In J. Herrington & B. Hunter (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2010* (pp. 1093–1097). Chesapeake, VA: Association for the Advancement of Computing in Education.

Irvine, V., Code, J., & Richards, L. (2013). Realigning higher education for the 21st-century learner through multi-access learning. *MERLOT Journal of Online Learning and Teaching, 9*(2). Retrieved from http://jolt.merlot.org

James, R., Krause, K., & Jennings, C. (2010). *The first year experience in Australian universities: Findings from 1994 to 2009*. Melbourne, Australia: The University of Melbourne, Centre for the Study of Higher Education.

Kember, D., McNaught, C., Chong, F. C. Y., Lam, P., & Cheng, K. F. (2010). Understanding the ways in which design features of educational websites impact upon student learning outcomes in blended learning environments. *Computers & Education, 55*, 1183–1192. doi:10.1016/j.compedu.2010.05.015

Lidstone, J., & Shield, P. (2010). Virtual reality or virtually real: Blended teaching and learning in a master's level research methods class. In Y. Inoue (Ed.), *Cases on online and blended learning technologies in higher education: Concepts and practices* (pp. 91-111). Hershey, PA: Information Science Reference. doi:10.4018/978-1-60566-880-2.ch006

Moore, M. G. (1993). Theory of transactional distance. In D. Keegan (Ed.) *Theoretical principles of distance education* (Vol. 1, pp. 22–38). New York, NY: Routledge.

McCue, L. S., & Scales, G. R. (2007). Embracing the middle ground: Engaging on- and off-campus students within the same 'classroom'. In B. B. Thomas (Ed.), *Proceedings of the 2007 ASEE Southeastern Section Annual Conference and Meeting* [CD-ROM]. Washington, DC: American Society for Engineering Education.

Norberg, A. (2012). Blended learning and new education logistics in Northern Sweden. In D. G. Oblinger (Ed.), *Game changers: Education and information technologies* (pp. 327–330). Boulder, CO: EDUCAUSE.

Okita, S. Y. (2013). Educational technology and instructional design in synchronous blended learning environments. In E. J. Francois (Ed.), *Transcultural blended learning and teaching in postsecondary education* (pp. 170–192). Hershey, PA: Information Science Reference. doi:10.4018/978-1-4666-2014-8.ch010

Park, Y. J., & Bonk, C. J. (2007). Is online life a breeze? A case study for promoting synchronous learning in a blended graduate course. *MERLOT Journal of Online Learning and Teaching, 3*(3). Retrieved from http://jolt.merlot.org

Pope, C. (2010, September). *Breaking down barriers: Providing flexible participation options for on-campus courses.* Paper presented at the Fifth Education Research Group of Adelaide Conference, Adelaide, Australia.

Popov, O. (2009). Teachers' and students' experiences of simultaneous teaching in an international distance and on-campus master's programme in engineering. *The International Review of Research in Open and Distance Learning, 10*(3). Retrieved from http://www.irrodl.org

Rogers, P. C., Graham, C. R., Rasniussen, R., Campbell, J. O., & Ure, D. M. (2003). Blending F2F and distance learners in a synchronous class: Instructor and learner experiences. *Quarterly Review of Distance Education, 4*, 245–251.

Roseth, C., Akcaoglu, M., & Zellner, A. (2013, May/June). Blending synchronous F2F and computer-supported cooperative learning in a hybrid doctoral seminar. *TechTrends, 57*(3), 54–59. doi:10.1007/s11528-013-0663-z

Shield, P., Atweh, B., & Singh, P. (2005). Utilising synchronous web-mediated communications as a booster to sense of community in a hybrid on-campus/off-campus teaching and learning environment. In H. Goss (Ed.), *Proceedings of the 22nd ASCILITE Conference* (pp. 607-614). Brisbane, Australia: Queensland University of Technology.

Spann, D. (2012). 5 innovative ways to use virtual classrooms in higher education. In M. Brown, M. Hartnett, & T. Stewart (Eds.), *Proceedings of the 29th ASCILITE conference* (pp. 864–866). Wellington, New Zealand: Massey University.

Stewart, A. R., Harlow, D. B., & DeBacco, K. (2011). Students' experience of synchronous learning in distributed environments, *Distance Education, 32*, 357–381. doi:10.1080/01587919.2011.610289

Szeto, E. (2014a). A comparison of online/F2F students' and instructor's experiences: Examining blended synchronous learning effects. *Procedia – Social and Behavioral Sciences, 116*, 4250–4254. doi:10.1016/j.sbspro.2014.01.926

Szeto, E. (2014b). Bridging the students' and instructor's experiences: Exploring instructional potential of videoconference in multi-campus universities. *Turkish Online Journal of Educational Technology, 13*(1). Retrieved from http://www.tojet.net

Szeto, E. (2015). Community of inquiry as an instructional approach: What effects of teaching, social and cognitive presences are there in blended synchronous learning and teaching? *Computers & Education, 81*, 191–201. doi:10.1016/j.compedu.2014.10.015

Szeto, E., & Cheng, A. Y. (2014). Towards a framework of interactions in a blended synchronous learning environment: What effects are there on students' social presence experience? *Interactive Learning Environments*. Advance online publication. doi:10.1080/10494820.2014.881391

Turoff, M. (1999). *An end to student segregation: No more separation between distance learning and regular courses*. Paper presented at the TeleLearning '99 conference, Montreal, Canada.

Vu, P., & Fadde, P. J. (2013). When to talk, when to chat: Student interactions in live virtual classrooms. *Journal of Interactive Online Learning, 12*(2). Retrieved from http://www.ncolr.org

Waddoups, G. L., & Howell, S. L. (2002). Bringing online learning to campus: The hybridization of teaching and learning at Brigham Young University. *The International Review of Research in Open and Distance Learning, 2*(2). Retrieved from http://www.irrodl.org

White, C. P., Ramirez, R., Smith, J. G., & Plonowski, L. (2010, July/August). Simultaneous delivery of a F2F course to on-campus and remote off-campus students. *TechTrends, 54*(4), 34–40. doi:10.1007/s11528-010-0418-z

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Thousand Oaks, CA: Sage.

Highlights

- Seven cases involving blended synchronous learning in university settings were analysed
- The cross-case analysis revealed 27 emergent design and implementation factors
- Students reported more active learning, enhanced co-presence, and greater flexibility
- The majority of students felt they learnt the same or more than in normal classes
- Tool performance, increased cognitive load, and equity between cohorts were issues

Acknowledgement

Funding for this project has been provided by the Australian Government Office for Learning and Teaching (OLT). The views expressed in this article do not necessarily reflect the views of OLT.