Building IT Capabilities to Deploy Large-Scale Synchronous Online Technology in Teaching and Learning

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Abstract. Through the use of a case study methodology, this paper presents a case of a large scale implementation of a synchronous teaching technology called Blackboard Collaborate by the School of Science and Technology (SST) in SIM University, Singapore. The technology Blackboard Collaborate is being used in SST to replace the typical "face-to-face" tutorial class experience of its students across 10 undergraduate degree programmes in 131 courses (or modules). This study aims to answer two research questions: (1) What are the IT capabilities that are needed to ensure the effective use of the synchronous online technology in a University's teaching and learning environment? and (2) How can these IT capabilities be developed within a University? It will present a theoretical model of what key IT capabilities a University needs in order to support the large scale deployment of a synchronous online technology like Black-board Collaborate.

Keywords: IT capabilities · IS solutions · Asynchronous online technology

1 Introduction

According to de Freitas and Neumann (2009), a synchronous system that collectively provides participants with the basic tools for synchronous communication has the following three core functions: (a) live audio and video; (b) shared visuals and/or whiteboards; and (c) text chat. In practice, enabling and ensuring the effectiveness of the use of this synchronous online technology in a classroom is not a trivial feat. It is a constant challenge especially in a University context where discussion that promotes critical and analytical thinking among students and professor/lecturer is crucial to a student's learning.

While IT capabilities have been discussed widely in a variety of contexts especially in the organization research literature, they have not been applied in the context of University's teaching and learning. Given the dynamic change in the education landscape especially with the introduction of Massive Open Online Courses (MOOCs), many universities have been struggling to incorporate new synchronous online technology into its teaching and learning practices. However, given the large amount of changes and resources involved in the deployment of these technologies, many professors are reluctant to leverage upon these technologies for teaching and learning.

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Often, they fear the changes will affect their teaching rating and impart their promotion. These have limited the adoption of these technologies for teaching and learning. Students may also face difficulties in adapting to these new technologies as compared to the familiar face-to-face lecturing. IT department often is confronted by the daunting task to convince and prove to both the professors and students that adopting these technologies would be beneficial.

Developing ways to overcome these challenges to assure the good adoption of these technologies by students and professors is one of the key drivers behind our study. Specifically, we are interested to answer two research questions: (1) What are the IT capabilities that are needed to ensure the effective use of the synchronous online technology in a University's teaching and learning environment? and (2) How can these IT capabilities be developed within a University?

Using a case study methodology, this paper presents a case of a large-scale implementation of a synchronous teaching technology called Blackboard Collaborate by the School of Science and Technology (SST) in SIM University, Singapore. The technology Blackboard Collaborate is being used in SST to replace the typical "face-to-face" tutorial class experience of its students across 10 undergraduate degree programmes in 131 courses (or modules). A minimum of three Virtual Synchronous On-Line Learning (VSOLL) sessions using the software system from BlackBoard Collaborate were conducted per course to cover the course content in each semester.

Each session is recordable and everyone would use a headset for audio communication. For non-verbal communication, students would interact with their peers and the instructor using the text-chat function. In order to ensure that audio is communicated in an orderly manner, a hand-raise button is available for each student to "raise" his/her hand before asking a question. This mode of teaching and learning mirrors closely to a face-to-face session in the classroom but they are taking place in a real-time, distributed-online environment, as demonstrated in the recording of an actual synchronous seminar conducted in Athabasca University's doctoral programme (Bainbridge 2015).

This paper describes how Blackboard Collaborate is used for not only teaching, but discussed what are key IT capabilities that are essential to assure the success of such large-scale deployment within a University context. Using interview and secondary data collected from the case organization, this study will present what are key IT capabilities that a University needs in order to support the large-scale deployment of a synchronous online technology like Blackboard Collaborate. By doing so, this study becomes one of the rare studies in the literature that looks into how IT capabilities can enhance and enable the Human-Computer interactions among students and professors to assure the successful deployment of a large-scale synchronous online technology for teaching and learning.

2 Literature Review

Large-scale implementation of Blackboard Collaborate is rare. Of the studies found, only Canada's Athabasca University is found to practice large-scale implementation of synchronous technology at its doctoral and master programmes in distance education

which are taught fully online using Adobe Connect with "no face-to-face requirements for completion of the degree" (de Freitas and Neumann 2009). Elsewhere the deployment of synchronous technologies is implemented at individual courses level. The University of Southern Queensland (Reushle and Loch 2008), the Southern Cross University (Rowe and Ellis 2010), and the Hong Kong University of Science and Technology (HKUST 2012) are some universities using Collaborate at a small-scale level. Hence, as far as we know, the teaching and learning literature lacks study that looks comprehensively into the ways in which large-scale deployment of synchronous online technology for teaching and learning can be achieved. With the growing emphasis on driving eLearning in a University context, this gap within the literature is an important area that our study seeks to fill.

Reviewing the existing literature on online learning, we noted that three theoretical framework stands out and they include the Blended Online Learning Design (BOLD) (Power and Vaughan 2010), the Community of Inquiry (Garrison et al. 2000) and Multi-access Learning (Irvine et al. 2013). Each framework provided ideas to inform us on the important elements that must be put in place in order for online learning to happen among students. For instance, Power and Vaughan (2010) argued that for online learning to be effective, we need a combination of synchronous online learning activities and asynchronous learning management system-based learning activities. Garrison et al. (2000) offered three key 'presences' for online learning to be effective and they are: (1) cognitive presence; (2) social presence; and (3) teaching presence. They asserted that when the professors and students experienced all three of these presences, a community of inquiry is formed and this is when online learning would take place effectively. Finally, Irvine et al. (2013) argued the importance of providing students with different course delivery modes (e.g. face-to-face or online) to personalize their learning experiences while taking a course. They reaffirmed that by providing such multi-access to various course delivery modes to students, learning experiences in an online context of students would be enhanced. Notwithstanding the various teaching and learning theories presented in the literature, there is little discussion on how to create such effective learning environment within a University context. Specifically, what are the key IT capabilities that are essential in creating such an environment remains unknown. This is one of the key motivations behind this study.

For the purpose of this study, IT capability is defined as "the ability to use effectively and deploy IT-based resources in combination or co present with other resources and capabilities" (Bharadwaj 2000, p. 171). We would like to argue that IT capability is essential as the development of that capability enables the organization to continuously leverage educational value from the system. One of the functions of IT capability is to enable the organization to develop, add, integrate, and release key resources over time (Wade and Hulland 2004). The challenge for any practitioner is to understand what contributes towards the development of IT capability within the educational context.

This paper views capabilities as sets of competences required by an organisation to successfully implement and use information systems; this done in line with the organizational strategic goals. To us, the extent of IT system success depends largely on the organization's ability to carry out and manage change processes. Removing current problems and hurdles to progress towards more integrated processes and systems is a

necessary means to achieving a leaner and more effective IT system. We will examine this further in a later section.

Reviewing the literature on IT capabilities, we found that there are different fundamental components or characteristics of organizational IS capability. They largely centre around infrastructure, networking, management capability human resources, technology assets or even IT enabled-intangibles and processes (Bharadwaj 2000; Ross et al. 1996). Not all IT capability frameworks could be used in the educational context. For example, Feeny and Wilcocks (1998) suggested a classification of nine IS capabilities consisting of Leadership, Business Systems Thinking, Relationship Building, Architecture Planning, Making Technology Work, Informed Buying, Contract Facilitation, Monitoring and Vendor Development. While comprehensive, the framework (at this level of granularity) serves little use for anchoring the development of IT capabilities in delivering synchronous learning. Indeed, writings on IS capability tend to be viewed within the dimension of business rather than educational processes (e.g. Kim et al. 2011; Agarwal et al. 2014; Raymond et al. 2014). Hence, the paper seeks to discover the effective key IT capabilities which results in the success of large-scale deployment for synchronous learning at Universities as in the case of ours. To do this, we need to deploy a research design to capture the processes taking place during implementation. We will discuss this further in the next section.

3 Methodology

The School of Science and Technology (SST) at SIM University (UniSIM) was selected as the case organization for this study. The school was selected for the following reasons. First, the senior management of the school decided to implement a school-wide use of a virtual classroom tool called Blackboard 'Collaborate' to conduct online synchronous classes for more than 3,000 students distributed across ten different degree programmes. As far as we are aware of, this is one of the largest online synchronous technology implementation in Singapore. Second, the success of such implementation inevitably requires strong IT capabilities to be nurtured and developed within the school. Third, data collected from the post-implementation review shown that the implementation was a successful one with almost no difference between student's grades before and after implementation. Fourth, due to the success of this implementation, the University is now considering extending the use of Blackboard 'Collaborate' to all the schools within the University which would involve an addition of more than 10,000 students. Overall, our findings revealed that the School had demonstrated its ability to develop strong IT capabilities to ensure the continued success of this implementation within the University.

The use of case method is ideal for our study because of two reasons. First, the large-scale implementation of this synchronous teaching tool across the school inevitably involves very complex interactions among business and IT staff, processes, hardware, software, and IT infrastructure that cannot be separately examined out of its organizational context (Pentland 1999). Hence, case method is considered one of the most effective research methods to uncover these complex relationships and its shared understanding among all the key stakeholders involved in this project (Klein and Myers

1999). Second, given the IT capabilities have not been examined in the teaching and learning context in the literature, an exploratory case study focusing on developing a theory to explained this phenomenon through the collection of rich data in a real world context is highly recommended (Eisenhardt and Graebner 2007; Pan and Tan 2011).

Data were collected over a three year, six-semester period from January 2012 to December 2015. The entire process can be broken down into three phases namely, preliminary, onsite interviews and post-hoc. In the preliminary phase, a comprehensively archival analysis of secondary sources (e.g. project documents, articles, videos and images) was conducted to identify key themes on IS capabilities that can be analyzed. This allowed us to fine tune the research design and interviewees for the subsequent onsite interview phase. In the onsite interview phase, interviews of all the key stakeholders were collected by a team of researchers. Each interview was digitally recorded in video/audio. This generates rich and thick descriptions on the implementation from interviewees that are critical to our study objective. An iterative data analysis process was adopted during these interviews which required the researchers to systematically and iteratively combed through the primary and secondary data sources mentioned above and validated it with our theoretical observations onsite and/or the existing literature (Eisenhardt and Graebner 2007; Locke 2001) to ensure close data-theory alignment. A preliminary research model was derived in this process with the potential constructs on IT capabilities identified and we have used this model as a "sensitizing device" (Klein and Myers 1999, p. 75) to guide our subsequent onsite interviews. This process is repeated until a state of theoretical saturation was reached i.e. significant overlaps in constructs start to occur in the subsequent data collected and the additional data did not provide new insights to corroborate, extend or refute the propositions of our emergent model (Eisenhardt 1989; Eisenhardt and Graebner 2007). In the post-hoc phase, a final round of confirmatory data analysis was conducted to ensure the reliability and validity of our model. When we uncovered inconsistencies during this phase, we would cross-check it with the researchers' field notes, discussions with colleagues, (Walsham 2006) and in some cases, clarifications with informants.

4 Project Background

The drive for the introduction of synchronous technology in SST stemmed from an operational key performance indicator (KPI) required by UniSIM for all schools to offer 50 % of her courses in a UniSIM defined "e-learning mode" of delivery. Ordinarily, a typical 5-credit (or 150 study hour) course would comprise of six, 3 h face-to-face seminars/tutorials delivered over a 6-week or 12-week duration, depending on whether the course had a laboratory element or otherwise. Should a course contain a laboratory element, the 6 face to face sessions will be delivered alternately with the laboratory sessions, making the course 12 weeks' long. The policy of converting a course to the "e-mode" entailed the removal of three, face-to-face classroom based seminars/tutorials and replace these with "e-mode" type learning. The senior management at SST after weighing and deliberating on various teaching delivery strategies as reported under "Introduction" and "Methodology" decided to adopt the delivery of the "e-mode" sessions for all converted courses using a form of synchronous on-line

technology over asynchronous methods. The selected teaching deployment resulted in the running of synchronous on-line seminars/tutorials for 131 courses converted to the "e-mode" in gradual phases on a semester basis over a period of three years. Table 1 describes the management's perceived value of deploying synchronous on-line technology over an alternative asynchronous delivery method, such as those deployed by MOOCs. The scale of successful deployment of virtual synchronous on-line learning (VSOLL) sessions at SST is not trivial requiring a total of 360, 3-hour, or 1080 h of VSOLL per annum. This would require a massive increase in IT capabilities required for SST to successfully sustain and deliver the 1080 h of VSOLL sessions with a consistently high quality of service to the 3000 students serviced (see Table 2 on implementation scale). Figure 1 illustrates the operational structure that was set up to support the mass implementation of VSOLL in SST. This is termed "Large Scale Synchronous Teaching Technology" (LSSTT).

Table 1. Benefits of a LSSTT environment

• Ability to design a unique course content presentation to fit local part-study environment that fits the student profile governed by locality and culture of learning
• Teaching of Science and Technology to fit local student profile/study environment must be media rich enabled by interactivity and collaboration
• Choice of session to attend in multi-group courses
• Conduct frequency not tied in to fixed schedule (ease on logistics)
• Self-paced learning with private "chat" channel to instructor
• Lesson delivery and attendance not confined to campus/classroom allocated – economical savings of flying in overseas guest lecturers as well as ability of faculty to conduct virtual lessons for students based overseas
• Playback review through archiving/recording (aligned with local learning styles of students at SIM University)
• Easing logistical requirements to hold face-to-face administrative meetings with teaching staff and students through the use of VSOLL for administrative meetings

5 Discussion

This section commences with a discussion of what we had uncovered in our study for the Large Scale Synchronous Teaching Technology (LSSTT) implementation in the School. Figure 2 illustrates the detailed steps adopted by SST to ensure the successful implementation of the mass VSOLL delivery over the measured period from January 2012 to December 2015.

Based on the iterative analysis of our data, we have uncovered the following IT capabilities that played a critical role in ensuring a successful and sustainable LSSTT system and they are identified as following: (1) IS Infrastructure Capability; (2) Content Delivery IS Capability; (3) Network Capability; and (4) Management Capability. The IS capabilities were identified through our iterative analysis of our collected data. Table 3 shows the list of interviews conducted within SST.

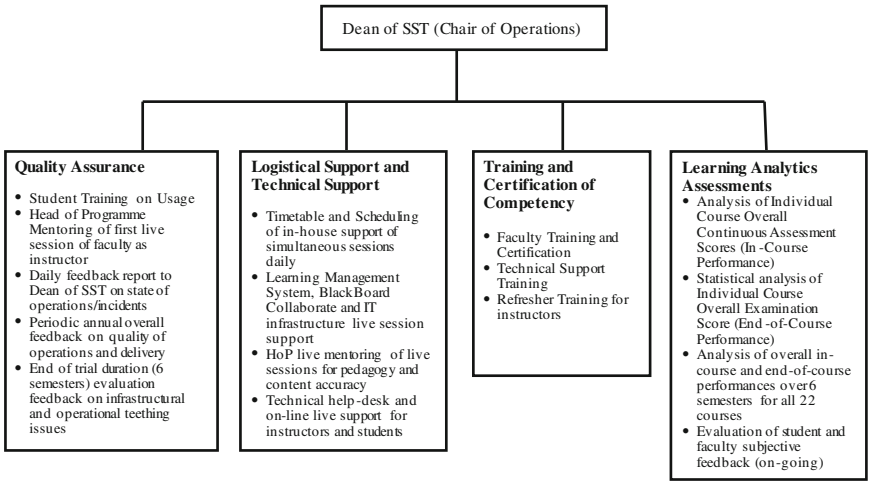

Fig. 1. Operational structure to support virtual synchronous on-line learning (VSOLL) on a large scale (LSSTT)

Table 2. Extent of scale of implementation of LSSTT in SST

• System supports the teaching and learning needs of 3000+ students in SST
• A total of 131 courses spread over 10 undergraduate degree programmes are currently running the "e-mode" of VSOLL delivery
• SST has a daily capacity peak of 22 VSOLL parallel sessions delivered simultaneously
• Over the period January 2012 to December 2015 (6 semesters) SST conducted a total of 2200 + h of VSOLL and conducted regular mass student and teaching staff briefings (up to a maximum capacity for 1000 simultaneous users)
• Currently running a microsite for 300 students selectively enroll to attend VSOLL sessions alongside SST students. The participants can choose any course from the list of available courses presented and join in discussion groups with the local students
• Use VSOLL to deliver an overseas guest lecturer from North Eastern University, United States on the History of Media. Local students gathered with their lecturer within SST premises whilst the overseas speaker delivered the lesson from his home in the United States in year 2015
• A faculty member conducted a class for about 100 postgraduate students from UNTAR University, Indonesia on Scientific Research methods. The lecturer was based in SST whilst the students attended the lessons synchronously on-line in Jakarta

When attempting to identify the nature of the IS capabilities within this LSSTT implementation, we attempted to distinguish IT capabilities into resources and processes. This approach is advocated in recent studies in IS capabilities (e.g. Agarwal et al. 2014) as extant literature in IT capabilities is often unclear about this distinction which often leads to conflicting and confusing results. Table 4 summarizes these IT capabilities required to support sustainable and high quality LSSTT in SST and the representative quotes extracted from our data collected.

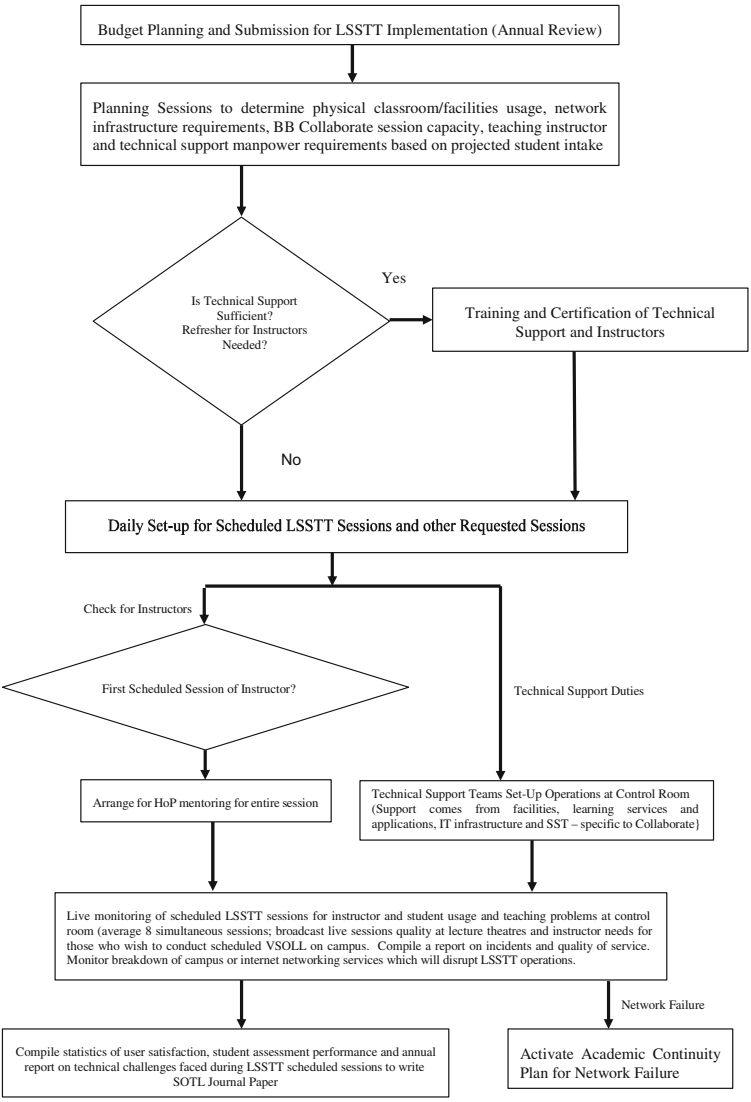

Fig. 2. Implementation of VSOLL at SST

6 IS Infrastructure Capability

As the professor/lecture delivering a VSOLL session no longer works alone but within the larger framework of other fellow professors/lecturers simultaneously (up to 22 courses to date) delivering content in a single evening to the part-time students in SST, the IS Infrastructure Capability must include the IT resources provided by UniSIM's Learning Applications and Services (LSA) as well as manpower from SST in the form of two full-time managers and a group of part-time IT specialists to provide operational

Table 3. Data sources to extract IT capabilities to support LSSTT through semi-structured interviews

Designation of Interviewees	No. of Interviewees	No. of Interviews
Technical Manager	2	4
Head of Programme	1	1
Experienced Teaching Staff	1	1
School IT Infrastructure and Laboratory Manager	1	1
Research Fellow	1	1
Senior Management	1	1
Total number of Interviews		9

on-line support to students and teaching staff for VSOLL content delivery. LSA, being a part of the university's Learning Services Cluster, provides manpower to support operations daily to users such as individual technical troubleshooting via the telephone and liaising with BB Collaborate the software service provider of the VSOLL system to handle issues such as academic continuity and dynamic service bandwidth provides to support the simultaneous VSOLL sessions every evening. Without the synergistic interactions and working collaborations between LSA and SST IT technical specialists/managers LSSTT technology cannot be successfully realized over the trial period of Jan 2012 to December 2015.

7 Content Delivery IS Capability

Prior to the introduction of VSOLL in January 2012, all professors/lecturers in SST have been training by the university's Teaching and Learning Centre (TLC) to deliver lecture content face-to-face. Introducing VSOLL introduced the new challenges of (1) the ability to effectively use the BB Collaborate VSOLL tool to teach synchronously on-line, (2) accepting on-line delivery from overseas academics at the same time possess the ability to deliver synchronous on-line content overseas and (3) reduce maximally the number of face-to-face meetings with students and teaching staff by providing the full-time academic administrators in SST with the ability to conduct synchronous on-line briefings to large groups of students and/or teaching staff, bearing in mind that SST provides only part-time degree programmes. The immediate availability of such manpower to delivery content and managed the delivery was not available in January 2012, but capability was gradually built up as the number of "e-mode" courses increased over the study period of six semesters.

8 Network Capability

Reviewing the work flow for network capability to recover to normal LSSTT operations as well as the provisions for academic continuity of LSSTT due to sudden network disruptions, SST relies on (1) its IT Managers to provide operational guidance/liaison with LSA/BB Collaborate as well as to students/staff, (2) the IT

Table 4. IT capability to support LLSTT in SST

IT Capability	Processes	Resources	Representative quotes
IS Infrastructure Capability	Resource Planning	• Learning Services and Applications Centre, UniSIM	"*Preparations for LSSTT must commence way ahead of start of semester to ensure that IT Network and Learning Application Resources are fully available to support LSSTT. Additionally, all required operational and teaching spaces must be pre-booked to before the start of the semester so that both support and teaching staff can have avail to these resources immediately*"
		• Budget to purchase supporting hardware and maintenance of hardware	
	Manpower for Daily Management of LSSTT Sessions	• Full-time technical managers	
		• Part-time IT specialists	
Content Delivery IS Capability	Ability to teach synchronously on-line	• Experienced and trained lecturers in VSOLL	"*Every teaching staff new to VSOLL must be accompanied by a HoP [Head of Programme] sitting aside him/her when delivering the first VSOLL lesson and this should be carried out on campus*" "*One must accept and embrace the new VSOLL technology and methodology in order to teach well synchronously on-line. This also entails conducting rehearsals before actual lessons take place so that one is totally comfortable during delivery*"
		• Training Rooms with networked PCs	
	Delivering Contents Overseas	• Establishments of MOUs	
		• Technical Management from SST	
		• Experienced and trained lecturers in VSOLL	
		• LSA second level support	
	Ability to conduct mass briefings to students and teaching staff (part-time)	• Technical Management from SST	
		• Experienced and trained full-time lecturers in VSOLL	

(*Continued*)

Table 4. (*Continued*)

IT Capability	Processes	Resources	Representative quotes
		• LSA second level support	
Network Capability	Ensured academic continuity under all operating conditions	• Technical Managers	"*Network integrity and adequate capacity is absolutely vital to ensure academic continuity in a LSSTT implementation*"
		• IT Communication System with students and teaching staff	
		• IT Logistics for alternative presentations (ITS)	
		• Network Dongles	
Management Capability	Consistent Quality of Teaching and Operations during a VSOLL session	• Quality Check for new teaching staff on BB Collaborate Competency	"*It is extremely important that every teaching staff is fully conversant with the usage of the BB Collaborate VSOLL Tool prior to the start of the first lesson*" "*From a strategic viewpoint, the synchronous on-line mode of lesson delivery offers features closest to that of*
		• Quality check at end of each evening on all simultaneous sessions	
		• Head of programme individual guidance at VSOLL sessions	*the face-to-face mode. Besides it offers a platform for overseas guest lectures to be delivered on-line, local teaching staff delivering on-line lessons to overseas students as well as a reduction of logistics by cutting down mass student and staff face-to-face meetings*"
		• Dean of School – organization of community of practice activities	
		• Faculty training in use of BB Collaborate as a VSOLL tool with competency test	

business continuity (BCM) expertise from the university's Infocomm Technology and Support Group (ITS) and (3) the rapid deployment of network dongle devices in the event of campus network failure.

9 Management Capability

Management Capability to co-ordinate and effect changes in a dynamic way is central to the maintenance of a high quality of service as well as sustain LSSTT in SST in the long term. As such, this essential function is led by the Dean of School who provides the strategic guidance and planning for the whole LSSTT delivery plan. He is assisted at the academic programme level, by the school's ten Head of Programmes (HoP), who are trained to manage the delivery of courses by teaching staff in their respective programmes. Each HoP ensures that a teaching staff delivering a VSOLL session for the first time is guided in a face-to-face manner. For this first delivery session, every first-time delivery of a VSOLL session must be carried out in a seminar room in the presence of both HoP and teaching staff for the full duration of the lesson. Teaching staff are then at liberty to deliver the remaining planned VSOLL sessions either in SST or outside the campus. A school Research Fellow (RF) specializing in the teaching pedagogy of VSOLL alongside an IT Technical Manager (TM) will jointly provide a series of training sessions to every teaching staff assigned to deliver VSOLL sessions. At the end of every training session, each teaching staff must pass a practical competency test to ensure that he/she is sufficiently competent to handle the technical requirements of delivering a VSOLL session. Although this appears superficially trivial, experience gathered through the running of such VSOLL sessions show that technical competency of the teaching staff delivering the lesson could "make or break" the morale/attention span of the students. After a presentation of VSOLL of four semesters, the school formed a Community of Practice (CoP) to promote VSOLL technology through the organization of a Collaborate Day, where experienced practitioners shared effective teaching strategies for VSOLL delivery in diversely different courses such as Mathematics and Biomedical Engineering, together with the "bells and whistles" of how to improve student participation/feedback on assessment of learning. In conclusion, the most important element of Management Capability involves the change management of mindsets in the technical support teams, the teaching staff, the HoP as well as students. This is additionally monitored through regular quality of service checks and audits.

10 Conclusion

This study started to answer two key research questions namely: (1) what are the key IT capabilities a University needs in order to support the large-scale deployment of a synchronous online technology like Blackboard Collaborate; and (2) how are these IT capabilities can be systematically developed.

Based on the case of UniSIM, we had identified the four key IT capabilities namely (1) IS Infrastructure Capability; (2) Content Delivery IS Capability; (3) Network Capability; and (4) Management Capability that are required to assure the effective large-scale deployment of synchronous online technology in the teaching and learning context. We had also provided a process on how these IT capabilities are systematically developed within UniSIM.

By addressing our research questions, this study has contributed to the literature and practice in the following ways. First, our study is one of the few attempts to examine IT capabilities in the teaching and learning context. We had also presented a viable IT capability development roadmap for other universities to mimic that we believed would be helpful in increasing the chances of driving such implementation. Second, our study contributes to the literature on IT capabilities and teaching and learning by extending this theory of IT capabilities into the field of teaching and learning. We believe this will enrich the discussion of IT capabilities going forward.

There are two limitations with our study. First, our inductively derived theory applied only to one case organization. To ensure its statistical generalizability, our theory can be tested by statistical means in future studies. Second, our study unfortunately only shed lights on how to implement a successful large-scale online synchronous teaching tool implementation. It does not shed light on how the success of this initiative can be sustained over time and on how to scale its success to include more students. Future research can consider adopting a longitudinal approach to provide more insights in these areas.

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