Virtual Classrooms as an Alternative Platform

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Abstract:
This paper provides an insight into National University of Singapore's journey of employing Virtual Classroom software to support business continuity and distance learning course. The paper focuses on the feasibility of employing virtual classrooms as an alternative platform. Lastly this paper also shares the university's experience of moving the Virtual Classroom to cloud, its benefits, shortcomings and the mobile platform opportunities opened up from this initiative.

Keywords:
Virtual Classroom, Web Conferencing, Cloud, Distance Learning, Business Continuity, eLearning, Online Classroom, WebEx

I.   Introduction

National University of Singapore (NUS) is a leading global university in Asia that offers wide range of undergraduate and graduate courses. In addition to the face-to-face on campus offerings, there are three university approved distance learning courses that employ various collaborative platforms. For example; Singapore-MIT Alliance and Temple University-NUS SAGE Certification Programmes are primarily conducted via video conferencing [3]. However the Master of Science in Financial Engineering, a multi-disciplinary programme run by Risk Management Institute adopts Virtual Classroom (*Figure 1*) [5] software for its distance learning students.

II.   Virtual Classrooms for Business Continuity

In 2007, National University of Singapore's Business Continuity Management Committee was formed to look into Business Continuity for administration, research and teaching. 'eLearning Week' at NUS (See Appendix A) was instituted to ensure uninterrupted teaching in the event of any infrastructural or health related emergencies such as SAR or H1N1 pandemic (Chandran, 2011) [4]. Virtual Classroom was recommended as one of the tools to conduct tutorials and seminar type classes. Appendix B shows the platforms that were utilized to deliver the lectures/tutorials during the e-learning week at Faculty of Arts and Social Sciences in Week 8 (04 – 08 October 2010). Around 10.7% used virtual class platforms while a small percentage used platforms like the CD-ROMs, DVDs or video conferencing. Initially the Staff and Students were bit apprehensive about online experience in contrast to the face-to-face teaching in a traditional classroom. Likewise the post virtual classroom session survey (Faculty of Engineering in Week 8, 05 – 09 March 2012)feedback from Staff and Students reflected a mixed response (See Appendix C) suggesting the potential for greater adoption if sporadic bandwidth or network issues are addressed .

Today in NUS, the Virtual Classroom platform is a seen as a viable option to conduct tutorials that involves real-time student interactions. The ability of Virtual Classroom tool to bring the teacher and the students on a common platform maximizes efficiency and business reach by facilitating uninterrupted teaching during emergencies.
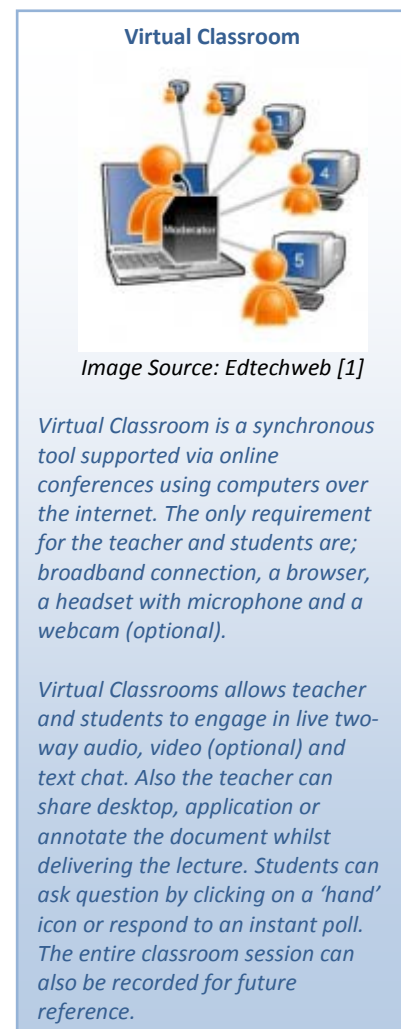

Virtual Classroom

Image Source: Edtechweb [1]

Virtual Classroom is a synchronous tool supported via online conferences using computers over the internet. The only requirement for the teacher and students are; broadband connection, a browser, a headset with microphone and a webcam (optional).

Virtual Classrooms allows teacher and students to engage in live two-way audio, video (optional) and text chat. Also the teacher can share desktop, application or annotate the document whilst delivering the lecture. Students can ask question by clicking on a 'hand' icon or respond to an instant poll. The entire classroom session can also be recorded for future reference.

Figure 1

The below chart reflects the rising trend in the use of virtual classrooms in the past business continuity exercises over the years. More supporting data are given in Appendix D.
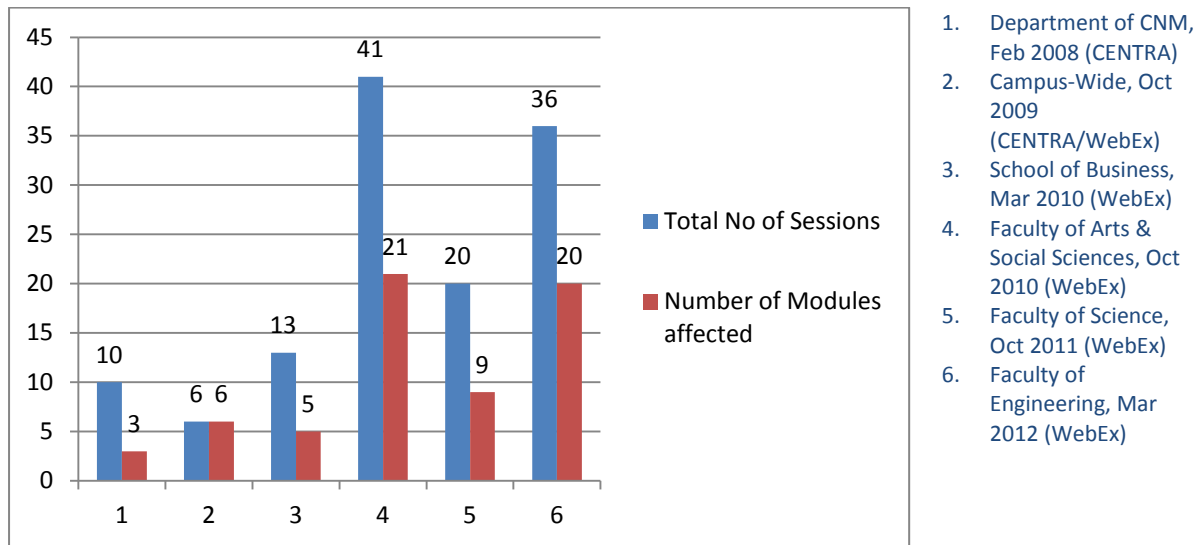

Figure 2 WebEx usage trend in NUS

1. Department of CNM, Feb 2008 (CENTRA)
2. Campus-Wide, Oct 2009 (CENTRA/WebEx)
3. School of Business, Mar 2010 (WebEx)
4. Faculty of Arts & Social Sciences, Oct 2010 (WebEx)
5. Faculty of Science, Oct 2011 (WebEx)
6. Faculty of Engineering, Mar 2012 (WebEx)

This perseverance to push virtual classrooms as an alternative platform paid off with few converts adopting virtual classrooms beyond the scope of business continuity. The usage ranged from simple trial session with overseas students for project, e-Mentoring, supplementary discussion, to presentation tool for a conference. These breakthroughs will motivate other potential repeat customers and open doors for more opportunities as the faculty buy-in sets in slowly.

III. Virtual Classroom to support Distance Learning

Centre for Instructional Technology (CIT) deployed a dedicated server (within NUS) in 2003 running Virtual Classroom application that facilitated the distance learning [2] course like Master of Science in Financial Engineering from 2005 to 2010 . The ability of taking a master's program across the border at your own pace works very well with the overseas students. Similar claims have been confirmed by Dian Schaffhauser (2011) [6] in her article that suggests students are drawn to Virtual Classroom due to increased flexibility that allows them seamlessly juggle between their professional and academic life. The Master of Science in Financial Engineering students follows the same curriculum irrespective of distance learning or on-campus mode. The distance learning students also have the flexibility to view the recordings after the live class sessions.
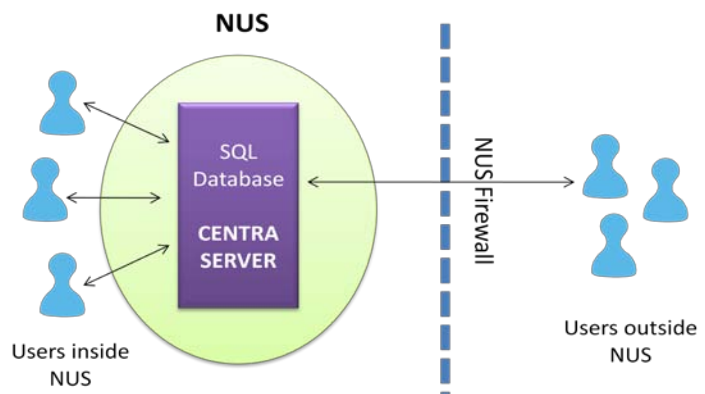

Figure 3: CENTRA setup in NUS

CIT acquired and installed CENTRA from SABA with limited license. There was an upfront cost ($115,000 to $125,000) and a recurring cost (10% to15%) involved in lieu of annual maintenance and renewal. Such dedicated setup (*Figure 3*) approach also exposed few challenges confronted by the IT team during the operations.

- Maintenance and Software Updates: CENTRA's physical server resides in the server room maintained and supported by Computer Centre (*Figure 3*); therefore it is subjected to their policies and authority. Any scheduled or unscheduled maintenance by Computer Centre caused direct impact on the virtual class sessions. Furthermore any updates and patches to administer on CENTRA server required to follow the prescribed procedures and to seek a formal approval from the system administrators where needed.

- Scalability: The ability to seamlessly scale up the infrastructure to meet the strategic needs of the university can be seriously stifled considering the cost involved. For example NUS Business Continuity Planning demanded infrastructure upgrade to conduct 'eLearning Week' across the faculties at a significant cost.

- Support: Vendor support response can take more time to resolve urgent issues whilst going back and forth before the root cause is identified. Providing full remote access to the vendor support team may directly conflict the organization's security policies.

IV. Adopting Cloud for Virtual Classrooms

Cloud Computing

Networks, Servers, Applications, Storage, Services etc.

It is an extensive collection of servers connected by digital network to serve as shared pool of configurable resources that can be easily deployed and managed with minimum effort and cost.
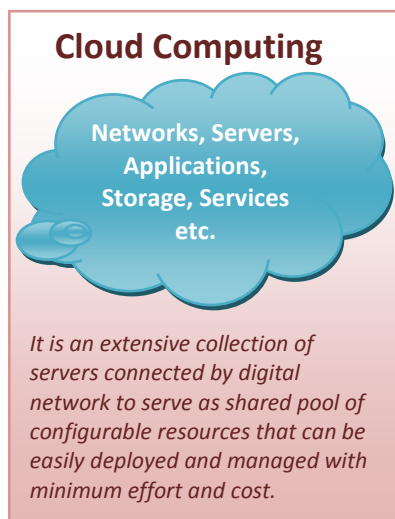
Figure 4

The Horizon Report (2010) [7] identified 'Cloud' as one of the four trends, a key driver of technology adoptions for the period 2010 through 2015. It points out the increasing adoption that is altering the way we use software, file storage and how we conceptualize those functions. Hence the browser based solutions that are device independent are poised for greater adoption.

In 2009, NUS's Computer Centre collaborated with CIT to soft launch CISCO WebEx [TM] Collaboration Cloud [10] to facilitate the real-time web conferencing for its academic and non-academic use. The cloud (*Figure 4*) is not only designed to aid large scale communication but also its service model software-as-a-service, SaaS (*Figure 5*) promises increased efficiency. Furthermore CISCO WebEx [TM] collaboration platform was developed ground up exclusively to delivery reliable and scalable meetings to offer competitive advantage. The below list briefly outlines few of the benefits of migrating Virtual Classroom to cloud;

- Cost: The cloud services are usually on subscription basis which means organizations need not allocate significant portion of their budget towards hardware and software licenses (in addition to the recurring cost of annual maintenance) instead organizations operate on pay-per-use basis.

Software as a Service (SaaS)

In SaaS delivery model the software is accessed on demand remotely from a central location via a web based service thereby reducing the cost for the organizations significantly.

Figure 5

- Infrastructural capability: The subscription model automatically isolates the organization from the traps of legacy systems. In contrast, it allows the organizations to exploit the flexibility of dynamic provisioning with minimal IT investment. For example SaaS model coupled with global load balancing supports full scalability based on the strategic and business needs, intelligent location based routing ensures consistent high performance, and the cloud service provider ensures the availability of the latest software version with all upgrades, patches including the regular maintenance.

- Data Security: For end users, the seamless and transparent global backup for data, audio, and video, ensures reliability throughout the class. Archived data is saved securely via multi-layered security model supported by enterprise policy controls that is inherent in the cloud.

- Support: CISCO WebEx [TM] cloud is developed to run at less than half its full capacity at any given time and is monitored continually. The capacity is automatically scaled up in the event of higher usage to maintain idle capacity. Furthermore, continuous improvement and regular maintenance ensures best performance.

- Mobile Support: Device independent solution offers a fertile ground to exploit the potentials of mobile platform.

V.   CISCO WebEx™ Collaboration Cloud at NUS

NUS's Computer Centre acquired 50 host accounts that came with 25,000 VOIP (Voice over Internet Protocol) minutes worth of free time. Other optional packages were included to address the needs of storage, custom integration and extra VOIP minutes. CIT looked into application support, training and outreach. CIT worked with individual staff and departments to support them on their various needs including Business Continuity and Distance Learning. For example a pilot run was carried out with a small group of staff and students from University Scholars Program (USP) during the campus wide eLearning Week in 2009. USP's post eLearning Week report reflected that instructors felt encouraged as this solution came closest in meeting their pedagogical needs in contrast to other rival products.

To maximise the usage, CIT also launched new initiatives like – Lunch 'n' Learn series. This allowed the staff to give free online talk on any topic that benefited the wider audience in NUS. The use this conferencing tool is also being promoted to conduct online meetings within and outside campus for administrative use. Until now the VOIP usage is well within the range of allowed free time (Appendix E).

NUS have deployed WebEx Node for ASR 1000 to enable an efficient connection for optimal performance. In broader sense, it is basically a shared port adapter to help reduce WebEx WAN (Wide Area Network) bandwidth usage significantly to facilitate lowered WAN cost and reduced firewall load (*Figure 6*).

The WebEx Node is a hardware module, or blade, for the Cisco ASR 1000 that runs WebEx software that extends Cisco WebEx Collaboration Cloud capabilities onto a campus-based enterprise network. As a module for the ASR 1000, the WebEx Node runs behind the corporate firewall, offloading WebEx traffic from the WAN, firewall, and proxy servers—blending best-in class capabilities of both SaaS and on-premise solutions.

Using the WebEx Node is particularly effective for high levels of concurrent WebEx usage on an enterprise network. The WebEx Collaboration Cloud and the WebEx Node for ASR 1000 series work together seamlessly to form a high-performance distributed collaboration switch fabric. The WebEx Node manages capacity automatically, routing overflow meeting participants to additional nodes—either on the corporate network or over the WebEx Collaboration Cloud. Meeting attendees outside of the enterprise firewall can still join directly through the WebEx Collaboration Cloud.

The WebEx Node is not a replacement for SaaS, nor is it a substitute for an on-premise web and audio conferencing solution. It is a shared port adapter that plugs into the Cisco ASR 1000 to optimize WebEx performance on enterprise networks.
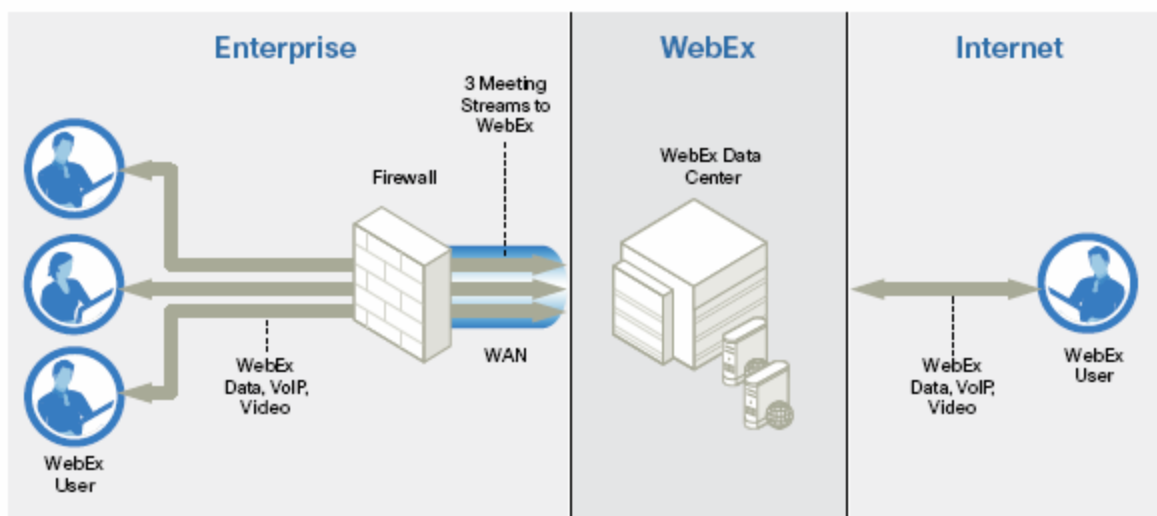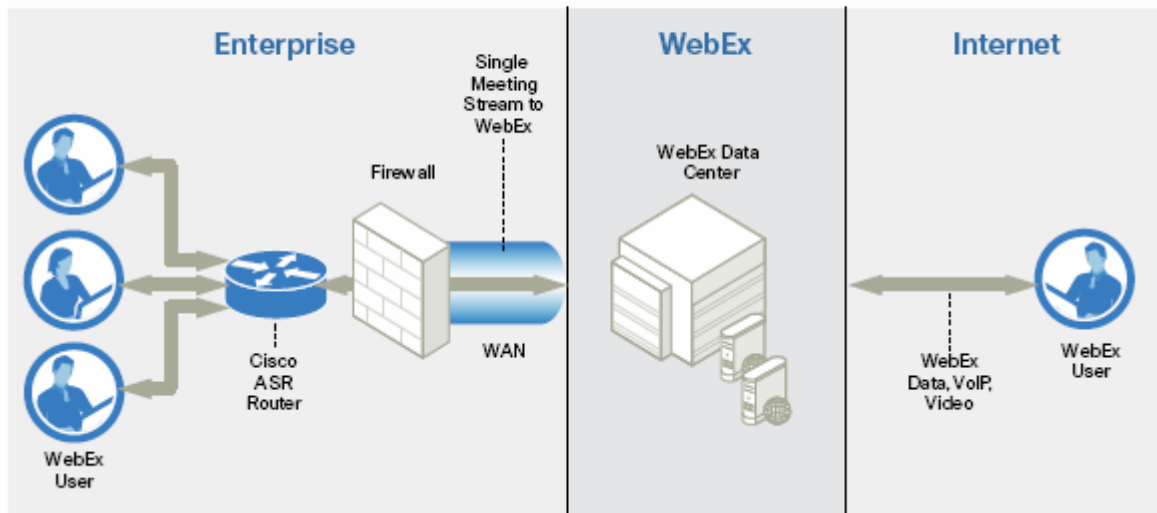
WebEx with Node for ASR 1000

Figure 6

In addition to the hardware upgrade, the software version was upgraded from WBS 27 Build 11 to WBS 27 Build 21. This exercise immediately widened the user base by including more recent browser version on MAC operating system. The improvement was observed during the business continuity exercise in different faculties. Less than 10 MAC users were able to join the virtual classroom successfully before and after the upgrade, the next business continuity exercise had 97 Mac users on board. Likewise WebEx Meeting Centre now supports new features such as high quality videos, active speaker mode and easy audio setup interface.

VI. What's next?

As part of continuous improvement, presently NUS's Computer Centre is exploring the possibility of implementing 'productivity tools' that will enable the staff to directly schedule the online sessions via Microsoft Outlook ^{TM} calendar.

Similarly Single Sign-on (SSO) allows the user to log into NUS WebEx site seamlessly. These integrations are in progress and are expected to be rolled out soon.

VII. Pitfalls of cloud services

In the context of academic settings, following are some of the confronting issues that may hold back the impetus.

- Content Privacy: The content security could be the most common concern for the staff on the cloud especially if the class is strictly meant for closed group of students. Staff apprehensions are further heightened by incidents like the Sony PlayStation Network data breach that compromised 77 million user accounts. Therefore any service that spells out public domain or similar model as delivery platform may intimidate certain end users. For example: It is not difficult to gain an unauthorized access to the online session with wrongly acquired link and the session password.

- Data Security: Cloud Security Alliance's research (2011) [12] cites insecure interface and API's as 2nd most top threat. The cloud service is venerable as it uses APIs for provisioning, management, orchestration, and monitoring. There is an urgent need to protect against accidental and malicious attempts to foil security apparatus. This also raises the need for sound data protection directives to address compliance concerns.

- Dearth of Standards: Absence of adequate standards for now makes the cloud potentially not interoperable. This could curtail the organization's roadmap until the standards evolve and mature [11].

VIII.   Mobile Platform Opportunities

In spite of the challenges encountered in terms of various operating systems and form factors, mobile learning has continued to be in the radar as emerging technology for teaching and learning. The eLearning guild research report shows immense potential as the organizations expand their intentions for mLearning (see appendix F) and as 70.2 % of mobile users today are using their personal device for work (Quinn, 2011) [13]. The eLearning guild research report also mentions about the immediate benefits of anytime anywhere access to information and communication that this ubiquitous platform offers (Quinn, 2011).

According to 2012 horizon report [8], mobile apps and Tablet computing are slated in near-term horizon that is, within the next 12 months. The report recognizes the pervasiveness of these two devises in the everyday life and its increasing popularity in the academic settings.

To that end, SaaS delivery model facilitates access to information and communication over free VOIP that works on 3G or Wi-Fi support Smartphone and Tablets as per the WebEx website [14]. Technically, Virtual Classrooms can be attended in many mobile platforms like iOS (Apple), Android (Google), Blackberry (RIM) etc. Having said, it may work well for passive flow of information like recorded sessions over 3G network but active participation with full collaboration may still prove to be a challenge. In other words, out of the four 'Cs' of mobile as mentioned in eLearning Guild research (See Appendix G), we can be confident about 'Content' and 'Compute' but we may have to wait for 4G network to realise the full potential of 'Capture' and 'Communicate'.
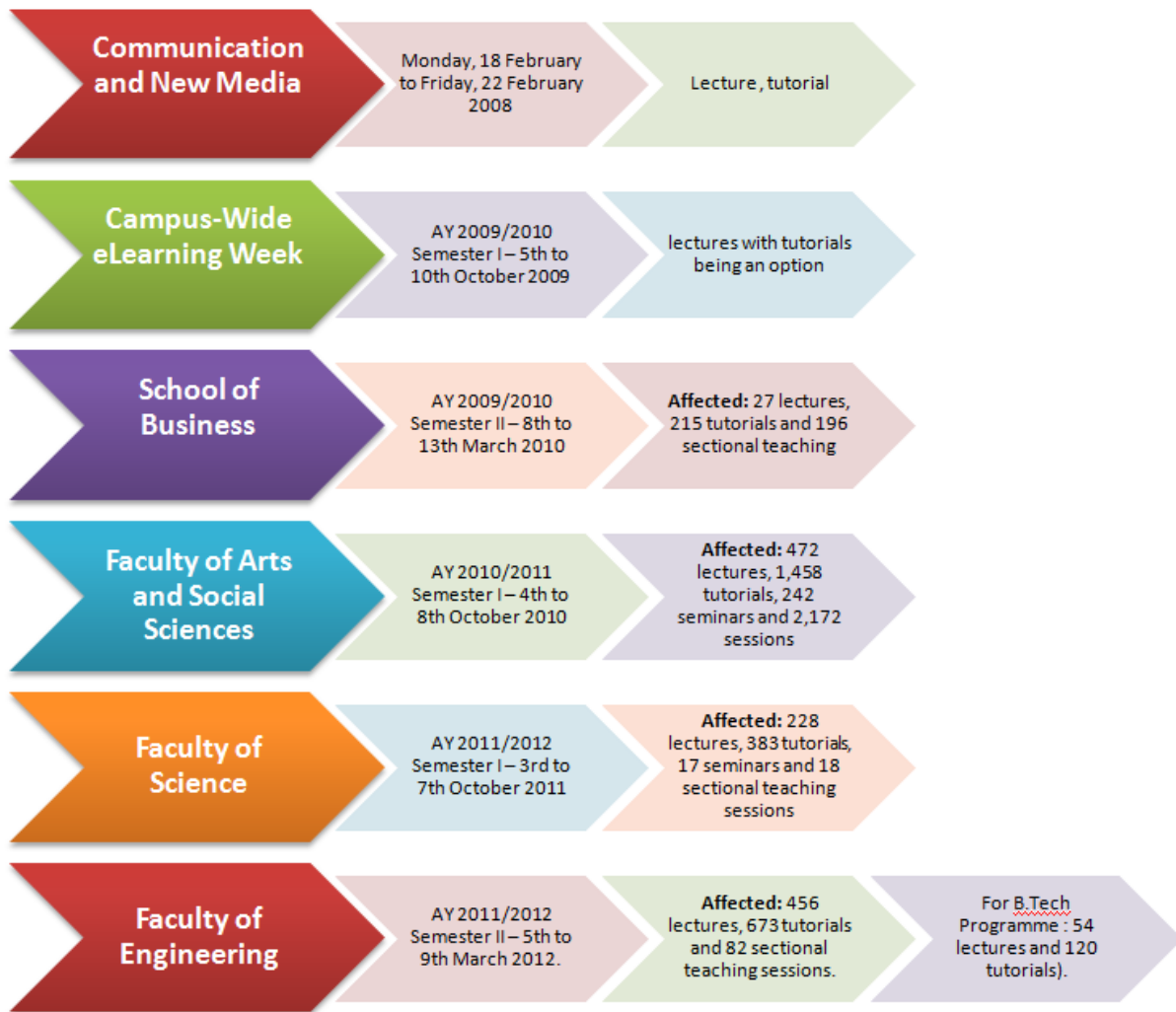
IX.   Conclusion

It is not uncommon to note the faculty resistance to adopt technology as the alternative delivery platform considering the pedagogical effectiveness and technology robustness. However these expectations can be moderated with upfront disclaimers on the technical impediments and adequate workarounds to overcome them. While there is no 'one size fits all' solution that may be applicable to all given the different teaching styles and needs for different subjects. The Institute of Higher Learning's (IHL) imperative must be to offer viable and functional delivery platform to facilitate teaching & learning. The importance is two folds when seen from business continuity standpoint. For those whose business needs demands seamless scalability affecting the whole campus, with the assured performance, data security and yet needs want to keep the investments low may want to consider the benefits of 'pay-per-use' advantage that 'Cloud' and 'SaaS' offer.
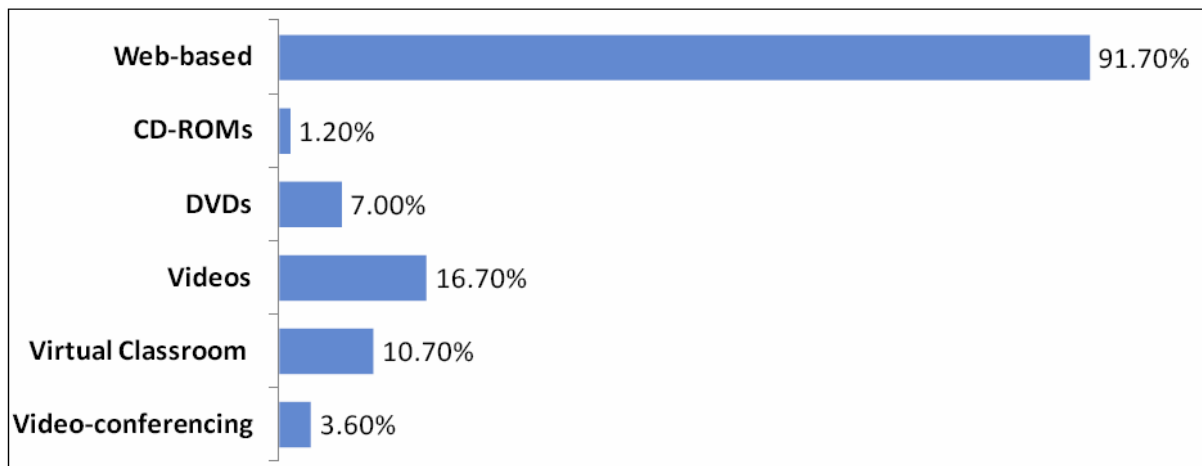
Reference:

[1] Edtechweb.wordpress.com, *Interactive and Collaborative Learning*, viewed 10th August 2011, <Image source: http://edtechweb.wordpress.com/2010/11/29/week-10-interactive-and-collaborative-learning/>

[2] Centre for Instructional Technology, *Distance Learning*, viewed 11th August 2011, <http://www.cit.nus.edu.sg/distance-learning/>

[3] Centre for Instructional Technology, *Web Conferencing*, viewed 11th August 2011, <http://www.cit.nus.edu.sg/web-conferencing/>

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[5] NUS Risk Management Institute, MSc in Financial Engineering, viewed 14th August 2011,http://www.rmi.nus.edu.sg/mfe/

[6] Schaffhauser, Dian 2011, 'The Problem with Classroom Technology? Faculty Can't Use It', Campus Technology, viewed 12th August 2011, < http://campustechnology.com/articles/2011/07/28/the-problem-with-classroom-technology-faculty-cant-use-it.aspx?sc_lang=en >

[7] *2010 Horizon Report* 2010, NMC and ELI, viewed 12th August 2011, < http://wp.nmc.org/horizon2010/>

[8] *2012 Horizon Report* 2010, NMC and ELI, viewed 10th April 2012, < http://www.nmc.org/publications/horizon-report-2012-higher-ed-edition>

[9] CISCO WebEx Solutions 2009, '*Why Web Conference, Why WebEx?*', Santa Clara CA

[10] CISCO WebEx White Paper, '*Powering collaboration: The Cisco WebEx Collaboration Cloud*', Santa Clara CA

[11] Dialogic, Introduction to Cloud Computing, viewed 12th August 2011, <http://www.dialogic.com/products/docs/whitepapers/12023-cloud-computing-wp.pdf>

[12] Cloud Security Alliance, March 2010, *Top Threats to Cloud Computing V1.0*, viewed 13th August 2011, <https://cloudsecurityalliance.org/topthreats/csathreats.v1.0.pdf>

[13] Quinn, Clark N. 2011, 'Mobile Learning: Landscape and Trends', *The eLearning Guild Research*, Santa Rosa CA

[14] CISCO WebEx, *Mobile Meeting*, viewed 15th August 2011, <http://www.webex.com/overview/mobile-meetings.html>

Appendix A: Past 'e-learning Week' conducted in NUS

Communication and New Media	Monday, 18 February to Friday, 22 February 2008	Lecture, tutorial	
Campus-Wide eLearning Week	AY 2009/2010 Semester I – 5th to 10th October 2009	lectures with tutorials being an option	
School of Business	AY 2009/2010 Semester II – 8th to 13th March 2010	**Affected:** 27 lectures, 215 tutorials and 196 sectional teaching	
Faculty of Arts and Social Sciences	AY 2010/2011 Semester I – 4th to 8th October 2010	**Affected:** 472 lectures, 1,458 tutorials, 242 seminars and 2,172 sessions	
Faculty of Science	AY 2011/2012 Semester I – 3rd to 7th October 2011	**Affected:** 228 lectures, 383 tutorials, 17 seminars and 18 sectional teaching sessions	
Faculty of Engineering	AY 2011/2012 Semester II – 5th to 9th March 2012.	**Affected:** 456 lectures, 673 tutorials and 82 sectional teaching sessions.	For B.Tech Programme : 54 lectures and 120 tutorials).

Appendix B: Platforms used for delivery of e-learning content

Platform	Percentage
Web-based	91.70%
CD-ROMs	1.20%
DVDs	7.00%
Videos	16.70%
Virtual Classroom	10.70%
Video-conferencing	3.60%

Source: Faculty of Arts and Social Sciences Summary Report, E-learning week (04 – 08 October 2010) (Faculty Survey - Report) – CDTL

Appendix C: Faculty of Engineering Student Feedback on WebEx

No.	Module Code	Date	Comments and Feedbacks (Total Received: 55)
1	EE4218	5-Mar	This is completely useless. I wasted 2 hours.
2	EE4218	5-Mar	Not very comfortable with having the webcam on during the session but couldn't find a way to turn it off from within WebEx
3	EE2021	5-Mar	It was smooth flowing but nothing beats a face to face discussion with the tutor.
4	EE2021	5-Mar	it's not very user friendly
5	CN4201R	5-Mar	Sometimes the network speed slow and voice not clear
6	CN4201R	5-Mar	Email should be sent out earlier to inform the students about this session. I only know of this session very late into the lesson
7	CN4201R	5-Mar	Please provide the correct link the first time. It was only by the third link I was able to join the lecture Also, if the lecture is starting at 4pm, being sent the link at 4:19pm is not beneficial. Other than that, this service is very good
8	CN4201	5-Mar	The sound volume of the speaker is too small
9	CN4201R	5-Mar	This form of e-learning is much better than the traditional webcast. I like the way we can interact with the lecturer and course mates privately or as a whole, making it good for a more interactive session especially since students in NUS are too shy to speak up in a lecture. Therefore, I think that it would be great for it to be implemented DURING normal lectures. This tool can even be used in place of lectures. The lower turn out can be partly attributed to a miscommunication as most of us are unaware of this new tool. I am sure that the next lecture would have a better turnout.
10	MT5007	5-Mar	It's really a great experience to have e-learning and I hope everyone also enjoyed this session. Hope in future we will have more of e-learning sessions!
11	MT5007	5-Mar	Better than SKYPE
12	MT5007	5-Mar	Not bad, but it's a pity that it's not recorded. I was informed rather late that the lesson was live and not recorded and thus missed a good half of it.
13	CE5603	5-Mar	can't be used on Mac operating system
14	EE3501C	6-Mar	Fail.
15	ES2021	6-Mar	Lag time
16	EE2024	6-Mar	Maybe the chat box notification can be more visible? A lot of times students tried to post question rather than speaking up, but the presenter couldn't notice their post. Thanks
17	Ee2024	6-Mar	Let's use this more.
18	EE2021	6-Mar	a little laggy
19	EE2024	6-Mar	too slow whiteboard and pdf slides could not be rotated
20	EE2023	6-Mar	Techs were helpful.
21	EG2604	7-Mar	Many were first time users of WebEx. Problems arose because of this. But once we get the hang of it, all went smoother.
22	EE2024	7-Mar	quite slow when presenting
23	EE2021	7-Mar	The technical support staffs are very helpful.
24	EE2021	7-Mar	I could not see the video of the Host
25	EE2021	7-Mar	Requires a steep learning curve, as different techniques have to be used.
26	EE2021	7-Mar	I had issues hearing the professor, however I think that may be due to the limitations of my computer. Thanks.
27	EE3501C	7-Mar	When the presenter is writing something, a blurb is shown instead, but it clears off eventually.
28	EE3501C	7-Mar	Sharing Apps and Desk top helps quite a lot. Good experience this time. Would like to continue using this for consultation time with students.
29	CN4201R	7-Mar	The host should be able to at least pinpoint with a cursor so that lecture can be followed more easily.
30	CN2401R	7-Mar	Please speak up. it's hard to hear
31	EE2021	7-Mar	Face to face is still so much better :)
32	EE2021	7-Mar	Everything works well but I don't see all the functions being fully utilized.
33	CN4201R	7-Mar	Encountered numerous problems running on Firefox 10.0.2 before switching to IE8. Audio was distorted and intermittent at times. Overall, the

| No.	Module Code	Date	Comments and Feedbacks (Total Received: 55)
			system is manageable but the typical IVLE webcast system is far more efficient than this.
34	CN4201R	7-Mar	It would be better if we can also see where the lecturer is pointing to on the slides.
35	ee2021	7-Mar	Cannot see if lecturer is pointing someplace, a bit difficult to follow...
36	CN4201R	7-Mar	Live webcast is bad, it is better to have a normal recorded webcast.
37	CN4201R	7-Mar	speaker kept speaking in auto tune or goes mute randomly, very distracting
38	ME5205	7-Mar	It simply does not open the file. I cannot attend the class!!!!!!!!!!
39	CE6002	7-Mar	The whiteboard is not clear enough to see.
40	ME5205	7-Mar	A job well done!
41	ME5205	7-Mar	Presenter to have a separate board to write for explanation, especially for analytical module like this.
42	ME5205	7-Mar	The slight difficulties were mainly due to lack of experience with the software!
43	ME5205	7-Mar	Hope to have more e-learning sessions like this. Part time students who are working need not travel all the way from the workplace to the campus to attend lectures. Anyway, good job!
44	ME5205	7-Mar	My internet download speed is low & I got pb of cutting out connection within the sessions...
45	ME5205	7-Mar	I had problem logging in as the session was locked. This is probably due to the inexperience in lecturer who has locked it. I spent 1 hour trying to enter the session, and so was also 1 hour late for the lesson.
46	ME5205	7-Mar	the poll button, green tick and cross should make larger and obvious
47	EE2020E	7-Mar	My computer hangs every time when the desktop sharing starts and I need to reboot the computer and join the web session again.
48	IE2101	8-Mar	Overall a very good experience. Students are more willing to ask questions as compared to in class.
49	IE2101	8-Mar	the chat session should be something like msn, where you can have numerous tabs for various ppl, instead of putting all the chats into one window
50	EE4307	8-Mar	The sound quality is an issue.
51	EE2024	8-Mar	Technical problem encountered: PDF file had some words not appearing when opening and sharing the document in WebEx (the words appear when using the Acrobat application itself)
52	EE2021	8-Mar	The start-up was a bit rough since it only worked on IE, but after that things were going smoothly
53	ME5103	8-Mar	Quite good, but still lack some of the "physical" feedback from the students as in a classroom. Difficult to express ideas that may need hand gestures.
54	EE2021	9-Mar	The audio not clear
55	EE2021	9-Mar	Classroom style tutorial would still be the best option. WebEx has its limitations.

Appendix D:

a) NUS WebEx Usage Trends in NUS over the years
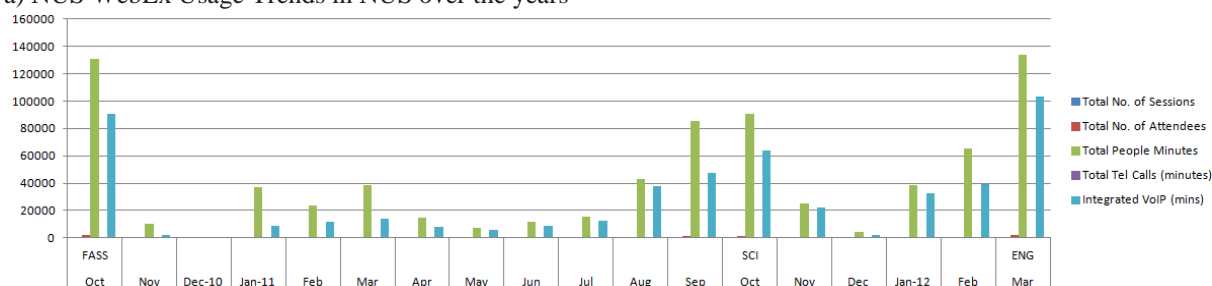
| NUS WebEx Usage	Oct FASS	Nov	Dec10	Jan11	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct SCI	Nov	Dec	Jan	Feb	Mar ENG
Total No. of Sessions	158	25	10	59	65	68	74	83	53	45	69	141	159	60	60	94	165	261
Total No. of Attendees	1915	107	20	390	374	562	214	194	158	285	509	1342	1571	367	130	457	811	2262
Total People Minutes	130939	10203	343	37001	23510	38760	14444	7132	11540	15287	43257	85260	90727	25064	4363	38547	65650	133912
Total Tel Calls (minutes)	101	0	0	0	346	30	147	65	301	0	286	102	264	172	187	32	2	0
Integrated VoIP (mins)	90854	2481	62	8916	11769	13967	7993	5533	9016	12898	37974	47866	63561	21976	2497	32441	39082	103169

b) Total No. of Sessions and Attendees
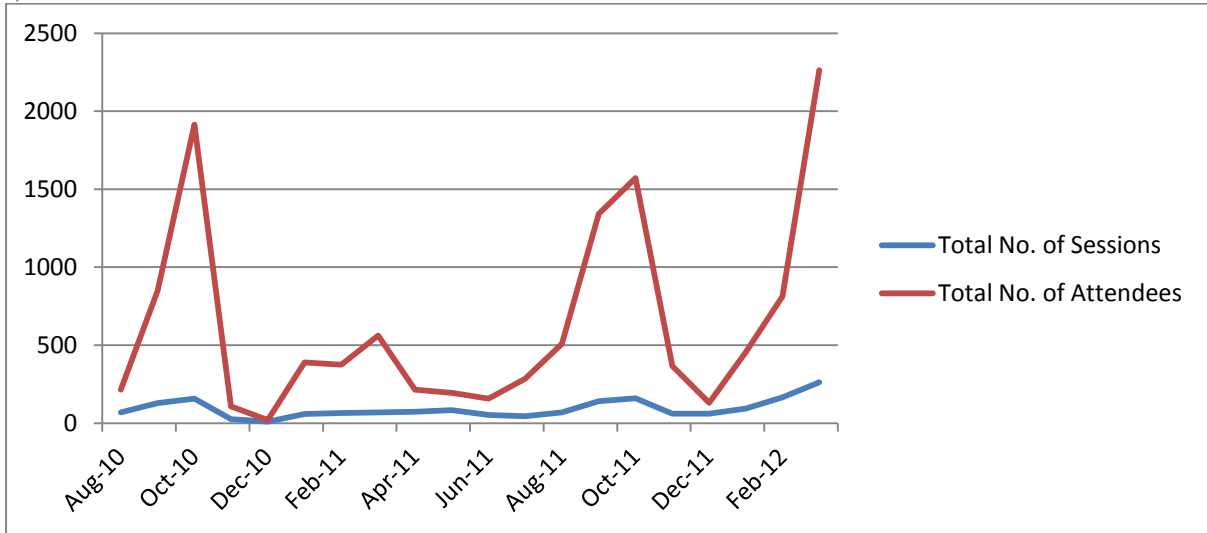
c) Total People Minutes, Integrated VOIP Minutes and Telephone Calls Minute
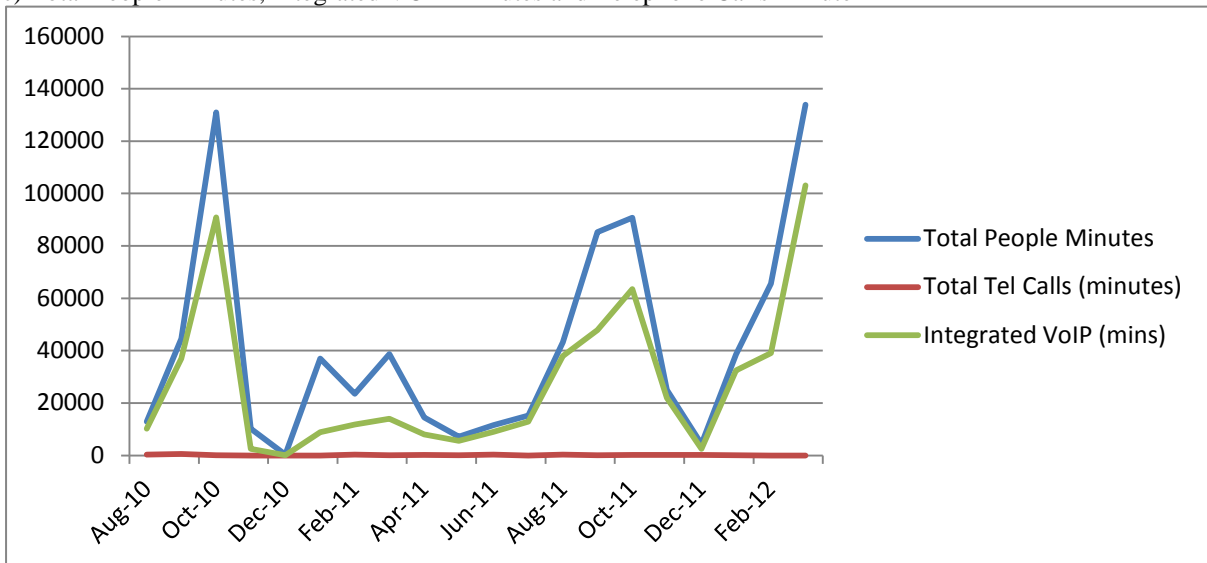
Appendix E: VoIP Usage in NUS

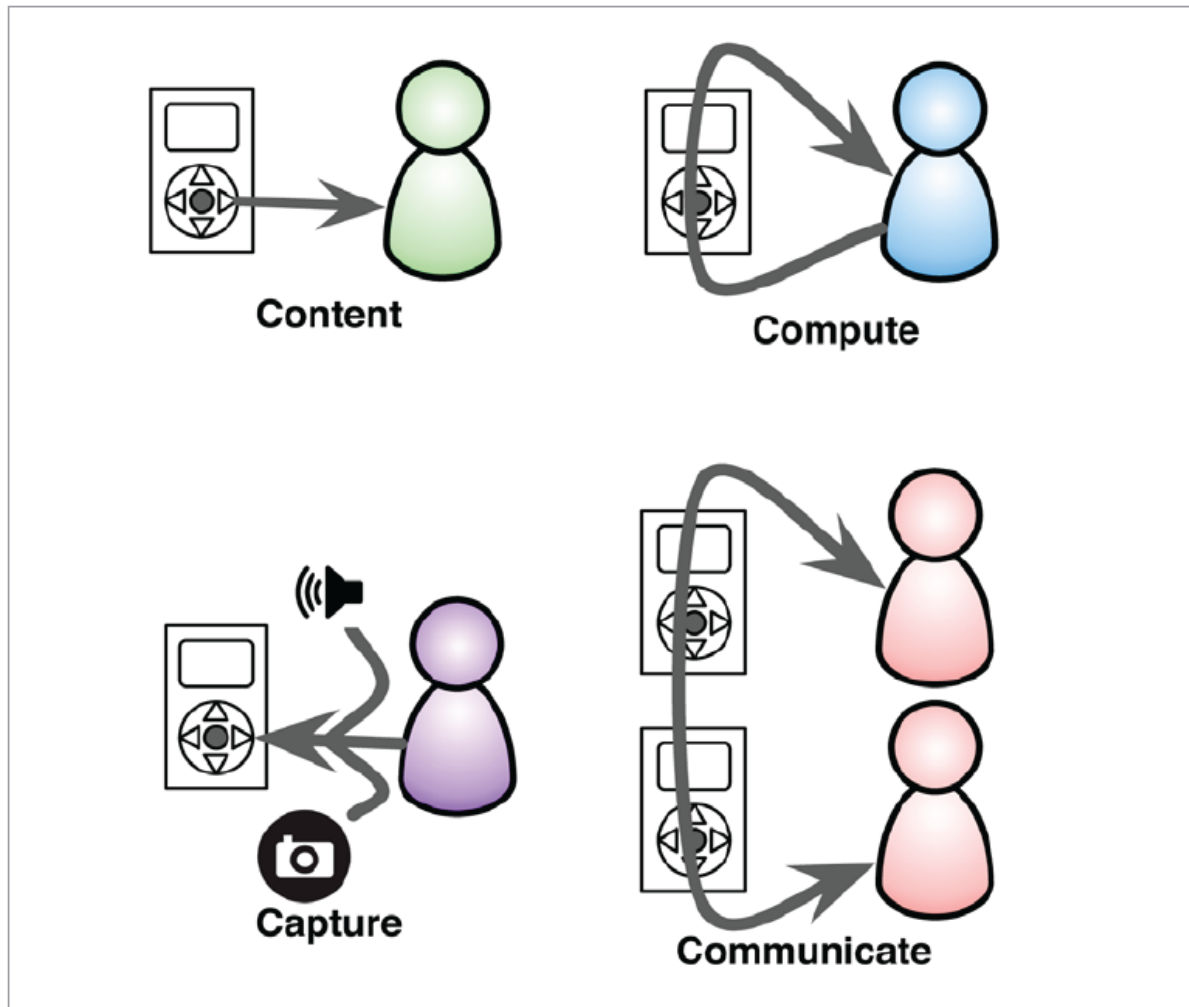| 2011	TotalMtgs	Total Duration	Total Attendee	Phone calls	VoIP
Jan	59	10570	390	0	8916
Feb	65	7477	374	346	11769
Mar	69	6727	562	30	13967
Apr	73	4348	214	147	7993
May	83	3556	194	65	5533
Jun	50	6435	158	301	9016
Jul	45	3958	285	0	12898
	444	43071	2177	1133	70092

Appendix F: Trends in mLearning Intentions
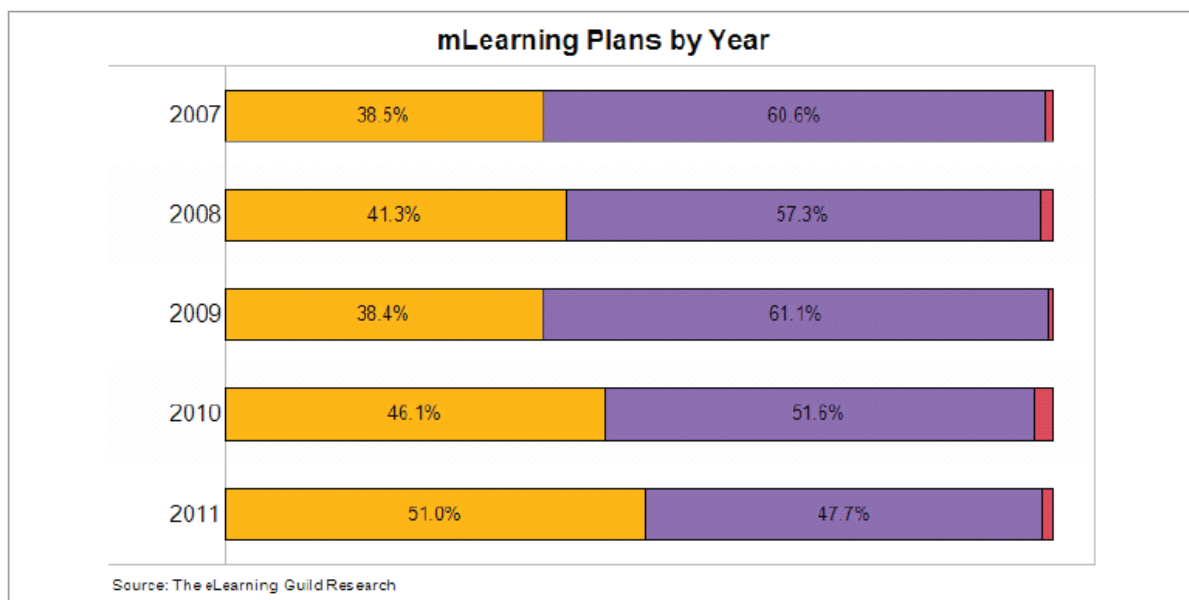
Source: The eLearning Guild Research

Appendix G: The Four C's of Mobile

• *Content* – the delivery of media including documents, audio, and video

• *Compute* – the ability to perform calculations and have programmatic responses

• *Capture* – capturing data from the local environment such as photos, videos, audio, or information from sensors such as location or direction

• *Communicate* – the ability to reach others with text, voice, or even video

Source: The eLearning Guild Research