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A Framework for the Comparison of Virtual Classroom Systems

Daniel McSweeney
Technological University Dublin, daniel.mcsweeney@tudublin.ie

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Daniel McSweeney
Institute of Technology Blanchardstown
Dublin, Ireland

Daniel.mcsweeney@itb.ie

1   Abstract

The increase in demand for open and distance learning has resulted in many higher education providers investing in virtual classroom systems. These systems can be an essential component in the delivery of flexible and online courses. While many institutions correctly place a greater emphasis on the pedagogical development of flexible courses, poor selection or implementation of virtual classroom software can reduce the pedagogical effectiveness of such courses and in some cases render them unworkable for both lecturing staff and students.

Changes in vendor offerings, the continual evolution of end user technology, developments in mobile devices and improvements in Internet infrastructure and services have resulted in need for continuous evaluation of virtual classroom systems and their capabilities to provide ideal environments for teaching and learning.

This paper provides a comparative analysis of two such virtual classroom systems (Adobe Connect 7 and Microsoft Office Live Meeting 2007) and examines their suitability in meeting both pedagogical and technological needs in Irish higher education. In doing so it suggests a comparative framework for other institutions engaged in the evaluation of virtual classroom systems.

Keywords: Virtual Classroom systems, synchronous communication, learning technology, distance education, adobe connect, Microsoft live meeting, virtual learning environments.

2   Introduction

In recent years there has been a concerted effort by providers of further and higher education to increase the levels of courses that offer qualifications though distance and flexible learning. Traditionally these types of courses have been delivered using asynchronous technologies both for the delivery of core course content and the facilitation of communication among participants. Paper based distribution of learning materials and postal based communication and submission methods have been replaced by ICT systems, in particular the VLE. Kear et al (2010) suggest that the benefits of using ICT on such courses are substantial. Firstly, ICT supports a resource-based learning approach where the students are given a wide choice of learning materials. Secondly it allows students to participate in 'virtual' communities. Finally it promotes an active approach to learning in line with constructivist learning theories.

Changes in education have often been driven by technology and the drive towards increasing participation levels in lifelong learning is particularly influenced by the adoption and availability of technologies useful in the delivery and management of learning. In their submission document to the HEA, Fox and Costello (2009) identify a range of technologies used in eLearning. These include synchronous and asynchronous communication technologies, learning resource technologies and combined resource and communication technologies.

The primary form of eLearning technology found in most higher education institutions is the VLE (Virtual Learning Environment). Most higher education institutions in Ireland are users of VLE's, however in most cases the use of a VLE by academics is not mandatory for teaching purposes. In most cases VLE's are used as content repositories rather than learning or communication tools (Cosgrave, Logan-Phelan, McAvinia, Risquez, 2008).

As well as acting as content repositories, many VLE's are used as a 'home' for academic courses and often provide links to a range of other eLearning technologies that may be used by students and academics. For example, in the Dublin region, a recent survey on the use of learning technologies highlighted a range of technologies in use in higher education institutes in the region. These included:

i.   Audio/Podcasting (Audacity, Voice Recorders, GarageBand)
ii.   Video (Video Conferencing, Camcorders, Echo360)
iii.   Collaborative Learning Tools (Blogs, Wikis, Voting Tools)
iv.   Resource Development Tools (Camtasia, Articulate, Wimba Create)
v.   Web 2.0 Tools (WordPress, YouTube, Delicious, Flickr)
vi.   SMART Technologies (Interactive Whiteboards, Symposium)
vii.   Assessment Tools (Moodle, Blackboard, Hot Potatoes)
viii.   Synchronous Learning Tools (Adobe Connect, Breeze, Blackboard)
ix.   Portfolio Tools (Mahara)

Source: DRHEA (2008)

On distance education and flexible learning courses, the typical VLE model require students to log into a VLE and access downloadable or electronic learning materials. Students are often encouraged to participate in online discussion forums and in many cases submit coursework or assignments using integrated VLE submission tools. In essence, VLE supported courses are often asynchronous in their nature. While forums and VLE based communication tools have provided some improvements

in the communication between participants on courses, it is the emergence of virtual classroom systems that is having the greatest impact on how courses are being delivered and how participants on these courses are interacting.

3   Virtual Classroom Systems

While web based conferencing and virtual classroom systems have been available in the marketplace for over a decade, recent advances in vendor offerings coupled with improvements in Irelands internet infrastructure has meant that those looking to deliver open and flexible learning can for the first time, look to virtual classroom technology as a viable delivery mechanism. Capital intensive communication technologies using video or phone conferencing, popular in the early and mid 1990's, have gradually been replaced with desktop based synchronous communication tools. A broadening in the range virtual classroom products has resulted in increased levels of competition and a steam of improvements in software solutions.

The differences between web conferencing tools and virtual classroom systems are often minimal. In many cases, the use of the term 'virtual classroom' is often used to describe web conferencing used in educational contexts. Virtual classroom offerings place an emphasis on using web conferencing technologies to replicate the core activities, interactions and channels of communication that would occur in a traditional classroom based environment. Virtual classroom sessions are often called web-based training, webinars, virtual meetings, and web conferencing (Stephens & Mottet, 2008).

Five key enterprise vendors dominate the current web conferencing and virtual classroom market: Adobe, Cisco, Citrix, IBM, and Microsoft (Info-Tech, 2008, Gartner, 2009). While the vendors solutions vary in terms of their underlying technologies and interface designs, many of the systems have common core functionality. Due to the similarity in core functionality, many evaluations (Schullo et al, 2007, Stephens & Mottet, 2008, Reushle & Loch 2008), focus on an evaluation additional functionality, ease of use or matching feature sets to the needs of proved pedagogical approaches. While the evaluation of virtual classroom systems in meeting the needs of pedagogical approaches is a vital aspect in the selection of an appropriate system, it is but one of many factors which must be considered when choosing a system. "A quality learning system is the foundation of virtual distance learning. It represents not only a significant investment and a competitive edge for a particular learning institution, but is also crucial to the success of the learning process" (Cloete, 2000).

4   Stakeholders for evaluation

Evaluations should involve representation from all major stakeholder groups within the institution. These include:

i.   Academics: The introduction of a virtual classroom system into a higher education institute can signal the beginnings of significant cultural and organisational change. While expecting that higher education institutes would embrace organisational change, in reality roadblocks to change are closely associated with the established practices and traditions of the

academic community. Academics familiarisation with face-to-face teaching and the perceived threat of alternatives such as distance and on line learners can be roadblocks to the introduction of virtual classroom systems. "The greater the degree to which a particular organizational practice defines and reinforces one's core professional identity, the greater will be the opposition and resistance to alternative practices and routines." (Jaffe, 1998). It is therefore key that any planned technology implementation and selection should involve academics as key stakeholders. "The collegial tradition of academic governance makes it unlikely that a technology strategy developed without extensive faculty input would have any impact". (Daniel, J. 1996).

ii.   IT and other support staff: Student and academic users of any virtual classroom system will require support from IT services and other support staff. In self-hosted environments, IT staff may have the primary responsibility for the installation and maintenance of systems. It is therefore essential that IT staff within the institute support the adoption any prospective virtual classroom system. IT staff should be involved in all stages of the evaluation and decision making process.

iii.   Students/End users: Where possible, involve students in the evaluation of any virtual classroom system. One possible method of achieving this involves the establishment of focus groups, formed from students who are already active in distance education courses within the institute. While rarely involved in the decision making process, students can provide valuable insights into initial user experiences, potential IT issues and usability issues.

5   Criteria for Evaluation

5.1   Vendor Characteristics

Before purchasing a system, prospective buyers should assess the vendors of the systems. Several key questions should be asked of any vendor.

i.   Position in the market: Is the vendor considered a leader on the field of virtual classroom solutions? While not ruling out solutions from newer vendors, market leaders are often leaders as their product is considered to be among the best solutions on offer to the market. Industry and academic studies (Info-Tech, 2008, Gartner, 2009, Business Software, 2010) often rank vendors in terms of their market share and user base.

ii.   Dedication to solution: How dedicated is the vendor to the product? Is the product a key aspect of their business? In many cases, the leading vendors of web conferencing and virtual classroom solutions are software companies who offer a variety of software solutions and services (e.g. IBM, Adobe, Microsoft etc.) and their virtual classroom offering may not critical to their business. In other cases, some vendors of virtual classroom solutions are single product vendors (Wimba/Elluminate, Dim Dim) and rely on their core offerings for survival. When assessing vendors, look for evidence of dedication to the product and service. This may be evident in trade reports, market share data and frequency of production releases and updates. Development roadmaps can also be useful in plotting the future direction of offerings.

iii.   Past performance: Does the vendor have a history of improving the product offering? This can usually be ascertained by examining product version history and update documentation that is often openly available on support sections of the vendors' website.

iv.   Customer support: What reputation does the vendor have for customer support? What types of support are available and are there extra costs associated with them?

5.2   Pricing Models

Vendors will offer a variety of pricing models for virtual classroom solutions. Some of the more common pricing models include:

i.   Institutional: A usage license is priced on an institutional basis. Intuitional prices are frequently calculated using a measure of the number of full time equivalent students enrolled within an institution.

ii.   Department or School: Similar to the above but localised pricing for individual departments or schools.

iii.   Per user: Based on the total number of anticipated academic and student users. Vendors will often apply a usage limit that can be increased based on usage demands.

iv. Per role: This model will attempt to price the solution based on the number of different users roles on the system. Clients will typically purchase a set number of host seats, instructor seats and student seats.

v. Per event: Based on the number of sessions held.

vi. Set time period of usage: Set number of calendar days.

Vendors will often use pricing models that combine a number of the above. Vendors may also change for items such as:

- Base Software License.
- Associated software.
- Installation media.
- Additional technical support .

5.3 Deployment Model

In most cases, vendors will offer two distinct deployment models, hosted or dedicated.

In the hosted model, the vendor will operate servers and software on behalf of the client, thus taking away much of the work involved in the setup, testing and day to day management of the technical infrastructure required to operate a virtual classroom platform. The vendor handles all product updates, backups and security checks. This model is ideal for clients who may not have the resources available to host and manage their own system or may simply wish to trial a system for a short term before committing to longer-term usage. Despite the attractiveness of these advantages, one key disadvantage lies in the fact that a key technology system is not within the direct control of the client institution. In many cases the choice of when updates to software versions occurs is not under the control of the client and may happen mid semester, sometimes resulting in changes to user interfaces or key features. This may negatively affect users of the system. In some cases a vendor may change their offering or cease the offering due to commercial circumstances.

The second, and in many cases more popular model for higher education institutions, is a dedicated in house deployment (behind firewall). In this scenario, the client hosts the virtual classroom system on their own network. This often requires the setup and management of multiple servers, software, databases and the associated overheads of the day to day management of a key IT system. While more suited to larger organisations or those in a position to manage the overheads, the self hosted solution gives the client total control over the system. This removes potential loss of service and upgrade issues and provides a level of certainty in ensuring the continuity of the service.

The choice of which model to adopt will depend on a number of factors including:

i. Cost
ii. Existing IT infrastructure and supports
iii. Stage of adoption
iv. IT policy on deployment and control of IT systems

5.4   Capacity and scalability

Many solutions offer licences based on a fixed maximum number of attendees per session. At the time of writing, the maximum number of attendees on an adobe connect (www.adobe.com/connect) named organiser meeting is 100. The adobe system can be scaled by using seminar rooms suitable for between 200 – 1500 users. There are of course additional costs associated with running seminar rooms that vary depending on a client's licensing agreement. Microsoft Live meeting standard licenses support meetings for up to 250 participants but like adobe, this can be scaled via additional spend.

Vendors may also license based on the number of concurrent users and this can have an impact for institutions which plan to run concurrent classes on the system with different instructors and groups of students. Other systems such as WizIQ (www.wiziq.com) do not place restrictions on the numbers of attendees in sessions.

For those planning to deploy in house, particular attention should be given to additional hardware and software requirements for increasing user numbers. Will the prospective system require additional servers and can it be scaled as it grows with your student base? Can the system be clustered or mirrored in line with best networking practice for demand driven applications.

5.5   Infrastructure

For those wishing to make use of an in house setup, consideration must be given to the hardware and software required to deploy the system. This may include (but is not limited to):

- Servers (web, file, database etc.)
- Software (server software, backup agents, database software, middleware)
- Network configuration (changes to firewalls, routers, additional network bandwidth etc.)

5.6   Client Technology

The first experience a student has with a virtual classroom environment is the setup of client software and access to the virtual classroom system. Models such as Salmons 5 Stage model of eModerating (Salmon, 2000) describe the important first stage of access and motivation. This stage can be marred for users who experience difficulties in setting up software necessary for access to the online environment.

In almost all cases, virtual classroom systems require some software to be installed by the end user. This may be in the form of a plugin or ActiveX control, JAVA or a proprietary technology such as Adobe Flash or Microsoft Silverlight. Several factors must be considered when assessing any client side software required by a prospective solution:

- Supported platforms: Is the client software cross platform? Are there differing versions depending on the operating system and end user system capabilities?

- Download size and footprint: How large is the file to be downloaded and how much free space is required on the end users machine?

- System requirements: Does the users system have to meet any minimal hardware or system requirements in order for the software to function?

- Required privileges for installation: Does the users need to have administration privileges to install the software on their system?

- Additional software: What additional software (if any) is required. Examples may include .NET, Java SE, Direct X etc.

- Required ports for end users: What ports are required to be open for connection to the virtual classroom. In the case of Adobe Connect, it uses the RMTP protocol that requires the default port 1935 (Adobe, 2010). Will end users need to make or request changes to firewalls in order to be able to access the virtual classroom?

The correct evaluation and selection of end user software can have a significant impact on the level of intervention required from IT and student support staff. For example, solutions which use Flash technology often require little or no action from end users as the plugin is supported by an average or 96% of end user systems (statowl.com, 2010) and is already present on most users systems. Virtual classroom solutions which make use of ActiveX controls or JAVA installations often require user intervention and installation privileges which in turn may lead to need of support from IT or support staff.

5.7   Ease of Use

How easy is the system to use? Suggested measures of ease of use include

   i.   Ease of environment setup (client plugin etc.)
  ii.   Ease of connection and room entry.
 iii.   Ease of communication between participants.
 iv.   Ease of broadcasting and document sharing.
  v.   Ease of collaboration.
 vi.   Ease of recording and archiving.
 vii.   Customisation of interface.
viii.   Accessibility for visually or auditory impaired learners.

A system that is easy to use can lessen the amount of time required by academic staff to train in the usage of the system. It can also improve users early impressions of the learning environment.

5.8   Training and Support Materials

The introduction of a technology platform such as a virtual classroom will often require training of the end users. Training is essential in allowing an academic to deliver an educational experience that matches their pedagogical aims. Can the vendor supply training and support materials that will facilitate the roll out of the system across the institute?

5.9   Support for mobile systems

As technology evolves, there is a growing demand for vendors to create virtual classroom solutions that can be accessed by users who make use of mobile computing systems. While not a new concept, the emergence of mLearing is largely being driven by a rise in popularity of mobile devices,

particularly those based on Apple IOS or Google Android. The popularity of these technologies has resulted in a surge in the numbers of students using mobile devices to access educational content and services. A recent Morgan Stanley report (2009) into the growth of mobile Internet offered several key insights that were of relevance to the virtual classroom market. They included

i. The mobile Internet is growing faster and will be bigger than the desktop Internet due to five converging technologies and social adoption trends: 3G, social networking, video, VoIP and impressive mobile devices.

ii. Use of the mobile Internet is driving mobile device growth exponentially faster that any previous computing technology. Mobile Internet devices (MID's) could reach 10 (ten) BILLION units in 2010.

iii. More users will connect to the Internet with wireless devices than desktop PC's within five years.

Potential virtual classroom solutions should offer support for mobile device access or at least have a solution within its immediate development roadmap.

6   Core Functionality

The following features should now be considered as core features for the evaluation of any prospective virtual classroom system.

6.1   Content Delivery

At its most basic level, virtual classroom systems should allow a presenter to present content to learners. In the case of most virtual classroom systems, content may be in the form of documents such as PowerPoint files, Word documents, Spreadsheets, PDF files, image files or a variety of audio and video files. The range of supported files and the treatment of such files vary from system to system.

6.2   Integrated video and audio communication

Again a basic core feature, most virtual classroom systems now offer integrated toolsets to facilitate the broadcasting of live video and audio streams. At its most basic level, a virtual classroom should allow the broadcasting of an audio stream from the presenter. Most of the market leading tools (Adobe Connect, Elluminate, Wimba, Microsoft Live Meeting) allow for the broadcasting of integrated VOIP among participants. Systems should allow for simultaneous streams for multiple room participants. Although declining in popularity due to increases in the quality of VOIP offerings, systems should also offer the possibility of integrations with audio conferencing systems for telephony based audio communications.

In many cases the use of video is limited to the broadcasting of the academic via webcam. Despite the debates on the actual educational value of the 'talking head', the ability for participants and instructors to broadcast webcam should be considered as essential.

6.3   Text chat

Text chat can sometimes be considered to be a legacy feature, which has lost importance following the introduction of VOIP (Voice Over Internet Protocol) functionality. However the facility of text based chat between participants can be valuable in allowing for private communication during sessions. It can also be an excellent tool for managing simple questions from large groups without the need to activate individual user audio privileges.

6.4   Collaboration Tools:

Core collaboration tools should include shared whiteboards, an ability to save and export whiteboards, document sharing, screen sharing, polls and surveys.

6.5   Desktop / Application Sharing

An increase in bandwidth coupled with advances in compression technologies has resulted in an increase in the numbers of systems that now offer screen sharing among participants. Almost all leading systems support screen sharing among classroom participants. Systems offer varying degrees of screen sharing including:

    i.   Broadcasting of instructor screen only.
   ii.   Broadcasting of any participants' screen.
  iii.   Remote control/access of participant desktop.

6.6   Participant Control

In virtual classroom environments, it is essential that instructors and hosts have some degree of control over the participants in the room. Participant control features may include abilities to:

    i.   Grant access to a room or remove a participant.
    ii.   Promote a participant to an enhanced role.
    iii.   Enable or disable participants broadcasting capabilities.
    iv.   Limit or grant usage to a feature of the room (document sharing, screen sharing whiteboards etc.)

6.7   Access Control/Security

Virtual classroom environments must provide a secure environment for participants. Systems should include secure user account creation and management, integration with domain services such as LDAP and password control to rooms and resources. Vendors should be able to provide evidence of internal and third party testing and security certification. Common application vulnerabilities include:

    i.   Injection flaws.
    ii.   Insecure communications.
    iii.   Insecure cryptographic storage.
    iv.   Malicious file execution.
    v.   Cross-Site scripting.
    vi.   Information leakage and improper error handling.

6.8   Session Recording

One of the key advantages of distance learning is in the fact that participants have a greater level of control as to when they choose to interact with the learning process. The ability to watch recordings of virtual classroom sessions allows users to miss a live session but still catch up on the content of the session. It allows users to view sessions multiple times to aid comprehension and retention of session content. Session recording should also allow for:

    i.   Access control to recordings (private, public, limited user access etc.).
    ii.   An ability to share access to recordings with VLE's.
    iii.   Downloadable recordings for off line playback (optional).

6.9   Breakout Rooms

Breakout rooms allow the academic or host to divide room participants into sub rooms to facilitate group interactions. These sub rooms should contain all of the features of the main room and allow for users to be promoted to different roles within the rooms.

6.10   File Sharing

File sharing should allow participants to share files through the virtual classroom interface.

6.11 Extensibility & interoperability

A virtual classroom system is often seen as one of several IT systems key to the delivery or management of learning within a higher education institute. As such, virtual classroom systems should be capable of integrating with other systems. This could include integrations with:

  i.   Learning management systems.
  ii.   LDAP servers or similar authentication services.
  iii. Student information systems.
  iv.   Reporting applications.

Systems which provide developer API's can allow customers to integrate their virtual classrooms with existing or new web services as well as enhancing functionality and integration possibilities.

7   A comparison of two systems using suggested evaluation criteria

The following evaluation was carried out in quarter 1 of 2010. The two systems compared are:

- Microsoft Live Meeting 2007

- Adobe Connect Pro 7.5

Due to the commercial sensitivity of the data, pricing models and evaluations of vendors commercial offers are not considered in this paper.

The comparison is based on a comparison of two in house hosted solutions (behind firewall)

A rating scale of 1 – 5 is used for each category

1	Poor
2	Fair
3	Average
4	Good
5	Excellent

Table 1 - Vendor Characteristics

	Adobe (Connect)	Microsoft (Live Meeting)
Position in the market	5	4
Dedication to solution	4	4
Past performance	4	3
Customer support	4	4
	17/20	**15/20**

Table 2 - Implementation Characteristics

	Adobe Connect	Microsoft Live Meeting
Deployment Model	4	4
Capacity and Scalability	3	5
Client Technology	5	3
Ease of use	4	3
Training and Support Materials	4	3
Support for Mobile systems	4	0
Infrastructure	5	3
	29/35	**21/35**

Table 3 – Core Features

	Adobe Connect	Microsoft Live Meeting
Content Delivery	4	4
Integrated audio and video communication	4	3
Text Chat	4	3
Desktop / Application sharing	4	4
Participant Control	4	4
Access control/security	4	4
Session Recording	4	3
Breakout Rooms	4	4
File sharing	4	4
Extensibility and interoperability	4	3
	40/50	**36/50**

Table 4 – Summary

	Adobe Connect	Microsoft Live Meeting
Vendor Characteristics	17/20	15/20
Implementation Characteristics	29/35	21/35
Core Features	40/50	36/50
	86/105	**72/105**

7.1 Key findings

i. Neither company is considered to be reliant on their virtual classroom offerings for core business although both companies would consider their products as an important part of their solutions catalogue.

ii. Both companies have excellent customer services and support reputations.

iii. Despite the release of some service pack updates, Microsoft Live Meeting 2007 has remained somewhat stagnant since its release in 2007. Since that time, Adobe Connect has moved from version 6 in 2006 to version 7 in 2008. Version 7.5, which was considered to be a major upgrade, was released in 2009 and at the time of writing version 8 is planned for November 2010. The number of upgrades and the improvements in each version would suggest that Adobe is more proactive in the development and enhancement of its solution at this time.

iv. Both companies can offer hosted or in house implementations.

v. While the Microsoft solution has a slight edge in terms of capacity and scalability, its system requirements and integrations with Outlook and back office servers make the setup and configuration of the system quite complex when compared to the relative simplicity of the installation process for Adobe connect.

vi. The client technology of the Adobe connect solution is based on Adobe flash. The Microsoft solution is divided into two possible clients, a windows client or a Web Access (JAVA based) client with a reduced feature set. In both instances, the Microsoft solution requires the user to install programs with the required system privileges. The adobe client is seen to be a much simpler solution for end users.

vii. Core features of the two products are similar. Users reported that the Adobe system was easier to use with a more intuitive user interface experience. As a result, the adobe implementation of many of the core features (audio sharing, content sharing, screen sharing etc.) was preferred.

viii. At the time of writing, there was no solution for mobile platforms for Microsoft live meeting. During the evaluation stage (Feb 24th 2010) Adobe released its Connect Pro® Mobile for iPhone® app which allowed users to conect to Adobe connect virtual classrooms via an IOS powered device.

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