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Beyond Videoconference: Increased Functionality to Enhance Media-Rich Interactions in Teaching and Learning

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Abstract

Modern technologies provide new approaches to tertiary education and will be an increasing component of the educational experience in the future. Their use poses a significant challenge to the design and delivery of teaching and learning as many teachers and students are unfamiliar with them in this context. Over the last decade there has been a very rapid expansion in the capability and usage of Information and Communication Technologies (ICTs) in teaching and learning. To use them effectively there is a need to understand how different ICTs can be applied to learning and teaching. Videoconference, Access Grid and Web Conference Applications (WCAs) are now available for use in higher education. The technologies are compared with a view to recommending which ones to implement for teaching and learning.

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Beyond Videoconference: Increased Functionality to Enhance Media-Rich Interactions in Teaching and Learning

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Abstract: Modern technologies provide new approaches to tertiary education and will be an increasing component of the educational experience in the future. Their use poses a significant challenge to the design and delivery of teaching and learning as many teachers and students are unfamiliar with them in this context. Over the last decade there has been a very rapid expansion in the capability and usage of Information and Communication Technologies (ICTs) in teaching and learning. To use them effectively there is a need to understand how different ICTs can be applied to learning and teaching. Videoconference, Access Grid and Web Conference Applications (WCAs) are now available for use in higher education. The technologies are compared with a view to recommending which ones to implement for teaching and learning.

Introduction

The University of Wollongong is a typical Australian university having a number of regional campuses as well as a main campus. While some of the campuses are relatively close (approximately within one hour's drive), others are up to five hours drive away. Since the early 1990s videoconference, allowing the exchange of video and audio of participants, has been used to teach across campuses, providing a significant time saving for students and teachers. Originally, videoconference endpoints were connected via ISDN (Integrated Services Digital Network. Switched, digital, telecommunications company owned lines). These conferences were expensive and not always reliable. Today, the Internet is used to connect endpoints where bandwidth is sufficient. The technologies considered here (Access Grid, Web Conference Applications and videoconference) all rely on dialogue between the connected users for learning to be effective and efficient. However, unless the sessions, or 'conferences', are recorded they are ephemeral and not available after the event. Recording of sessions or 'conferences' allows asynchronous use for purposes such as revision, for assessment, to cover absences, and others.

Videoconference is a mature technology in teaching and learning. It has been used for more than 15 years at the University of Wollongong. It was believed that the enhancement of learning experiences through the addition of other functions not normally found in videoconference was overdue. Other technologies such as Access Grid and Web Conference Applications offer these 'other functions'. The 'other functions' refer to shared eWhiteboard, presentation sharing, application sharing, and presentation of mathematics symbols as well as the saving of the resulting files. These functions enhance synchronous teaching and learning and, when recorded for later use, asynchronous learning. Web Conference Applications (WCAs) are defined here as suites of Web-based applications that permit sharing of applications, a computer-hosted whiteboard (or eWhiteboard), videoconference and other collaborative tools. As Web Conference Applications are synchronous, students can take advantage of them to discuss, question and interact. In this way the technology can assist in achieving deep learning. Moreover, if the conference is recorded, as mentioned earlier, the files can be used for other purposes such as revising the subject. For clarity the three technologies, videoconference, Access Grid and Web Conference Applications are referred to here collectively as Real Time Communications technologies or RTCs technologies.

The main motivation to replace videoconference by other Real Time Communications was that videoconference is often limited to discussion between participants and/or short presentations; RTCs offer wider variety of educational tools, such as eWhiteboards and presentations. Furthermore, Real Time Communications technologies have the potential to increase the efficiency and effectiveness of teaching and learning for a distributed cohort of students. For instance, RTCs can unite a teacher based at one location with students at a number of campuses into a synchronous class, providing access both between the teacher and the students and a mechanism for students' interaction at different campuses.

RTCs technologies are designed to be used synchronously. However, RTCs interactions can be recorded and used asynchronously by students who did not attend the class or for revision. The files that are recorded for later use are useful for students who are unable to attend even lecture due to have part time jobs. An important part of the education process is answering student questions during the lecture. This allows misconceptions and difficulties to be dealt with as they arise. It is important that students who miss a lecture have an opportunity to see these 'asides'. Furthermore, online systems that foster cooperation, collaboration, social, and active learning are believed to provide opportunities for deep learning (Caladine 2005).

Comparing the Technologies

The list of criteria by which the technologies were evaluated is listed below. The criteria were based on essential and desirable requirements for teaching and learning, and the demographics and computer resources available to students. The criteria are:

- Mathematics Symbols: This is an essential criterion for courses that use mathematics such as science, engineering, mathematics and statistics. Teachers must be able to provide problems and worked solutions.
- Shared eWhiteboard: An electronic whiteboard that is shared between locations. Anything written on the eWhiteboard at one location immediately appears on all connected eWhiteboards.
- Application Sharing: This allows participants in different locations work on a common file simultaneously (for example spreadsheets, presentations and documents).
- Two-way Communications: Two-way audio and video communications allow interaction between participants, for instance, teacher and students, and is considered to be the fundamental defining characteristic of the technologies compared (Daunt 1997, Kobayashi et al. 1997, Caladine 1999).
- Quizzes, Polls and Surveys.
- Cross Platform: Can operate a variety of operating systems such as: Windows, Macintosh, and Linux computers.
- Text Chat: For use as back up and support in the event of technical difficulties or for non-intrusive discussion.
- Recordable: The interactions and displayed information can be recorded and replayed for later use such as asynchronous learning.
- Cost:
 - ◊ Set-up cost; for example: equipment, room fit-out, video projector, camera(s), audio equipment, computer hardware and software,

- ◊ License fee, with the exception of Access Grid, all of the applications have a license fee. Access Grid is open source and has no license fee, and
- ◊ Operational costs; for instance: consumables, technical support (some suppliers provided technical support and in other cases it was left up to the institution), and bandwidth requirements which supports different bandwidth connections.

Presentation of Mathematics Symbols

The presentation of mathematical symbols is essential for courses that use mathematics such as science, engineering, mathematics and statistics. Students and teachers in these courses must be able to represent mathematical and scientific symbols to communicate the discipline appropriately and thus lead to deep learning. In videoconference mathematical symbols can be displayed when they are included in the presentation such as PowerPoint, LaTeX or others. They can also be represented by use of a document camera. Resolution was found to be an issue when a document camera was used with Access Grid and its use was discouraged in favor of an eWhiteboard. These principles also apply any subject in which symbolic representation is required and can therefore be generalized to a broad range of discipline areas.

Evaluation

A variety of RTCs are available for use in higher education. Their number is too great for a hands-on evaluation of each one. A two-stage evaluation strategy was therefore adapted. In the first stage a list of suitable RTCs was constructed by considering the criteria against advertising and promotional materials. In the second stage a trial of each short-listed RTC, which included WCAs such as Marratech, Elluminate Live, Wimba, Breeze, Centra (virtual classes), was conducted to check their ease of use, effectiveness and efficiency in teaching. The trial was conducted in a number of ways due to problems gaining access to all of the WCAs. For some, supplier demonstration provided sufficient data to address the criteria. For others hands on experience was obtained through free trials and access to licensed users of the application. For each RTC the trial verified some of the findings against the listed criteria and provided qualitative data on ease of use. At the conclusion of the evaluation, recommendations were made.

The criteria were selected based on their relevance to the needs of teachers and learners, the institutional infrastructure and the experience of the authors. The criteria (shown in Tab. 1) had to satisfy both departmental and institutional requirements. Institutional criteria include cost, maintenance and technical support.

Discussion

Access Grid, videoconference and five Web Conference Applications, the RTCs, were compared using the criteria, Mathematical Symbols, Shared eWhiteboard, Application Sharing, Two-way communications, Electronic Capture, Quizzes, Polls and Surveys, Cross Platform, Text Chat, Presentation (Live, Archived), Participant Management, Breakout Room, Cost including: Set up/Hardware, License/Software, Operation support and bandwidth.

For some criteria there was no significant difference from one RTC to another. Therefore some criteria could not be used to differentiate between the potential success or otherwise of different RTCs in teaching and learning. For the criterion two-way communications, all but one of the WCAs was successful. The unsuccessful WCA was eliminated as there were problems with its support of two-way audio let alone two-way video. All evaluated RTCs with the exception of videoconference provided shared eWhiteboard, a separate text chat tool and true application sharing.

Criteria		Access Grid	Videoconference	Marratech	Elluminate Live	Wimba	Breeze	Centra
Mathematics Symbols		Yes	Yes, via document camera or PowerPoint	Yes	Yes	Yes	Yes	Yes
Shared eWhiteboard		Yes	No	Yes	Yes	Yes	Yes	Yes
Application Sharing		Yes	No	Yes	Yes	Yes	Yes	Yes
Two-way Communications		Yes	Yes	Yes	Yes	One-way audio. Two-way audio available with permission	Yes	Yes
Electronic Capture		Yes	No	Yes	Yes	Yes	Yes	Yes
Quizzes, Polls and Surveys		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cross Platform		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Text Chat		Yes	No	Yes	Yes	Yes	Yes	Yes
Presentation (Live, Archived)		Yes	No	Yes	Yes	Yes	Yes	Yes
Participant Management		Not Applicable	No	No	Yes	Yes	Yes	Yes
Breakout Room		Yes	No	No	Yes	Yes	Yes	Yes
Cost	Set up/ Hardware	Room based node – medium PIG - low	Endpoint - medium Bridge - high	Server - medium	Server - medium	Server - medium	Server - medium	Server - medium
	License/ Software	Open source – No license fee	Included – firmware	License – medium/high	License – medium/high Based on number of concurrent users	License – medium/high	License – medium/high	License – medium/high
	Operation (support)	Technician – medium	Technician – low	Technician – low (server support)	Technician – low (server support)	Technician – low (server support)	Technician – low (server support)	Technician – low (server support)
	Operation (Bandwidth)	Medium/ high	Medium	Medium	Medium	Medium	Medium	Medium

Table 1: Access Grid, Videoconference, Web Conference Applications (WCAs) and Selection Criteria

Operational support was one criterion which emerged as having impact at the institutional level. For example, the technical support for Access Grid was found to be far higher than that for the other RTCs. For this reason, it is recommended that the use of Access Grid in teaching and learning is restricted to instances where high levels of technical support are readily available. Operational support levels were low for all other RTCs.

The WCAs evaluated all featured the facility to record and archive sessions. Access Grid Recording can be achieved through an additional piece of open source software called AG-VCR. However, the resulting files are large in size and can only be replayed with the Access Grid software. There are several ways in which videoconferences can be recorded. Some hardware vendors provide (at extra cost) servers that record the audio, video and computer presentations. Individual institutions have developed other systems. For example at the authors' university videoconferences are recorded using an in-house streaming/podcasting system.

Some of the WCAs offered participant management. This was not viewed as a positive feature of the WCA as it was seen as a way to control who participates when, and was judged to engender a teacher centered approach. Perhaps for classes where student numbers are very high, participation control will be a necessary tool.

From an institutional perspective, costs are an important criterion. The costs criterion was subdivided into:

- Set up costs that include the hardware and physical changes (furniture, walls, lighting, etc) needed for the technology
- The fee and structure of any license agreement
- Operational costs in terms of the technical assistance required, and
- Operational costs in terms of the bandwidth required between locations.

License software costs were medium to high for WCAs while for Access Grid, as it was an open source application, no license fee was required. For videoconference as the software is included in the hardware (firmware), it is impossible to differentiate between hardware and software costs. With the introduction of any new technology to teaching and learning there is a concomitant staff development cost. The more complex or difficult to use the technology, the higher the staff development cost. While staff development costs were not evaluated for each RTC it is assumed that they will be approximately equal for all WCAs and videoconference. For Access Grid, in cases where technical support is limited and the teacher undertakes some of the operation, the staff development costs will increase.

Videoconference has medium to high set up costs due to the need for a device (bridge or Multiple Conference Unit, MCU) to support multipoint conferences. While Access Grid requires no Bridge or MCU the set up costs are still medium due to the extra technology required. For example, Access Grid requires echo cancellation equipment, multiple projectors and cameras. WCAs have medium set up costs for hardware and software if the decision is made to host locally. Most WCAs are available with either of two cost structures for their licensing. In one the meetings or classes are hosted by the supplier and in the other the institution can purchase and install a WCA server. The second option is more expensive in the establishment phase but there are ongoing cost reductions in the bandwidth required for communications due to the local nature of the server and participants. All RTCs are subject to costs when they use an Internet Service Provider (ISP) and logically the greater the bandwidth required the greater the cost. Many institutions have minimized this cost through establishing their own network. The authors' experience, and anecdotal evidence from other users, indicated that the technical support costs for Access Grid were high in comparison to the medium costs for technical support of the other RTCs.

Access Grid was selected for the School of Mathematics and Applied Statistics at the University of Wollongong to take part in an inter-institutional collaboration in mathematics teaching and research. A shared culture of use was seen as important for uptake of the Access Grid. It was chosen essentially as it enables participants to feel that they are in the same room because of the many concurrent communication s channels. Other features of Access Grid are:

- It uses multicast Internet protocol , so no bridging or MCU technology was required
- The software allowed end users to see images of all participants all the time and to select the size (small, medium or large) of each image
- Application sharing
- Provided two-way audio and video

- Control of computer images by any participant
- True application sharing (for example, spreadsheets, movie viewers, eWhiteboard and computer desktop sharing)

Conclusion

Adopting Access Grid technology has high initial costs. Currently, two versions of the software are in use. Extrapolating the difference in user friendliness between these two versions it was predicted that in 3-5 years time the Access Grid software will develop to a level where significantly less operational support is required. In addition, in 3-5 years time improvements in compression algorithms will provide more efficient use of bandwidth; the general trend towards higher bandwidth connections is expected to continue. These changes will lead to a decrease in the bandwidth required by Access Grid and hence lower costs.

In terms of the technical functionality the Access Grid can be pedagogically superior to videoconference and Web Conference Applications as it provides video and audio of all participants as well as shared desktop, applications and whiteboard. As Access Grid uses multicast no local, expensive bridging technology is required. This makes Access Grid more cost effective.

While it is difficult to obtain exact figures, it appears that most Australian universities use videoconference in teaching and learning in some subject areas. It also appears that more than half Australian universities have room-based, Access Grid facilities. However, anecdotal evidence suggests that the Access Grid is rarely used for teaching and learning at Australian universities.

Access Grid facilitates functions such as eWhiteboard and shared presentations that are not available as part of the videoconference hardware. As Access Grid, Web Conference Applications and videoconference are functionally different, it is not recommended that all three should be used for teaching and learning at any one university. This is based on the extra costs that would be incurred, increased support required, and the extra time for students and teachers become familiar with different technologies.

At the University of Wollongong this research has led to the decision that Web Conference Applications will not be used in teaching and learning for the next 3-5 years. Videoconference will be used for teaching and learning for at least the next 3-5 years. During this time further evaluation will determine if Access Grid can replace videoconference for teaching and learning. Within the same time frame it is also proposed to combine videoconference with technologies that permit the sharing of eWhiteboards and applications. There will be an ongoing evaluation of these developments.

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