



e-Learning – Enabling the Classroom

Delivering effective e-learning to pupils with or without broadband

Fuelled by the Government's ambitious targets to promote and extend PC-based learning, more and more schools are now using this form of teaching delivery method. It has been demonstrated that e-learning is not only an extremely effective way of delivering information, but also enables lessons that are taught using other delivery methods to be consolidated, and ensures that consistent standards of material can be used throughout all schools.

Existing teaching materials have been modified by traditional companies, such as Pearson, to make them suitable for PC delivery. These companies, along with new content providers like Espresso Education, have also created new material tailor-made for this environment.

As part of the drive, the Government has set a target to connect every school to the internet via a broadband connection by 2006. The wealth of graphic-intensive and multimedia-based material being used, however, has already seen demand outstrip supply. To have all schools using e-learning techniques would put an intolerable strain on any conventional broadband infrastructure, whether at LEA, grid or internet level.

The solution is to acknowledge that PC-based teaching material does not always need to be online, in the sense that provided the information is current it is not essential that it is delivered directly to the lesson from the internet. In fact, in many instances, 'live' delivery can be a disadvantage, particularly if it involves delays that could de-motivate students and cause difficulties for teaching staff. The solution is to use the best of both worlds: a combination of locally-stored and internet-delivered information.

Caching and content delivery

Any information that is stored in order to be used as part of a lesson is generally referred to in the UK educational market by the generic term 'caching' (or 'edge' caching). But



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this simplification is slightly misleading as it actually combines two technologies – content delivery and caching. Although the two technologies are so complementary that they can be combined in a single product, such as Equinet's market leading CachePilot, it is useful to think of them initially separately.

Content delivery devices are used to access material from e-learning providers such as Espresso Education, 4Learning and Immersive Education. These devices sit at the school and essentially hold the same information as a parallel device (a web server) sited at the content provider's premises. Because the information is stored locally, no external connection needs to be made in order to deliver it to PCs on the school's local area network. So, no matter how many pupils need simultaneous connection, performance isn't an issue.

The size of the information typically stored in content delivery devices is enormous – tens of Gigabytes – too large to deliver over the internet. The internet connection is used instead to keep this information up-to-date and to deliver new content. This is done automatically, usually overnight or at weekends, and slower lines - such as ISDN or lower quality broadband - can be used effectively. This scenario gives schools the big advantage that valuable bandwidth is kept free during the day

Content delivery, too, is the technology that makes it possible to deliver digital video across the network. Even with a broadband line, delivery of online video across the internet is disappointing, whereas a caching/content delivery product such as Equinet's CachePilot can deliver cached video to a whole suite simultaneously.

Caching also has a big part to play in the e-learning arena, again storing information close to the users whenever possible rather than on distant and unpredictable websites. Because people in the same environment tend to use the internet to access similar material, web pages that have been requested by one user are stored locally. When the same page is requested by another person on the network it is delivered straight from the cache, without using the internet and without delay. The internet is only used if



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information has changed and needs updating. In this way, web browsing is speeded up considerably and bandwidth usage is minimized.

Another feature of caching, which is particularly useful for schools, is that pages can be 'pre-cached' ahead of them being needed in a lesson. Teachers can store all the web pages they will need while they are preparing the lesson, quickly and easily, so that material is delivered instantly in the classroom scenario. The risk of a website being unavailable when it is needed is eliminated, and delivery is fast, whether it is to whiteboards or to students' individual PCs.

Why is it best to combine a cache with a content delivery device?

A limitation of a traditional cache is that it stores data sequentially: as and when it arrives, and not in any ordered form. So, even if a complete web site had been cached over a period of time, it would be interspersed with other sites and web pages on the same caching device, and introduce its own delays whilst searching for each page.

A typical e-learning site is far too big to fit into standard caching products, and also too big to be efficiently navigated even if it could, since a new search of the cached content would be required for every page requested.

For e-learning material to be delivered effectively at academic establishments, it should be done so from a local source that replicates the original data in a structured manner. The local appliance providing this function should also be capable of automatic content updating as and when required, and be able to deliver its content to many students simultaneously, all of which is beyond the capability of standard caching technologies. A 'caching appliance' that includes both caching and content delivery technology is the best approach. It should have the following functionality:

Pre-caching

Teachers should be able to easily configure the appliance to pre-cache and regularly update web pages or sites to be used in their lessons.

Automatic web mirroring

The appliance should be capable of automatically checking its content against a remote server containing the source content data, and copying any new or modified files and directories. This would usually be done on a daily or weekly basis, and occur during the night or weekend.



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Central distribution

The product should also be capable of receiving updates and modifications pro-actively sent to it from the remote server holding the source content data. This is a useful function where many local caching appliances under the control of a single authority are remotely updated by that authority.

Web serving

E-learning content is almost exclusively web-based, so a web server built into the appliance would ensure its delivery locally without additional hardware. This would also add resilience against network failure, as all local PCs would point directly to the server held locally on the appliance, which would in turn deliver the content also held locally as a replica of the source content.

Structured data store

The ability to faithfully replicate the directory and file structure of the source content is important as this will enable the speedy retrieval and delivery of the content without unnecessary searching.

Management statistics & logs

It is likely that both the controlling authority and the content provider would be interested in the access patterns and statistics of users, and these should be presented in a standard format ready for easy analysis. This data may also form the basis of charging for the service. It is also important that all updates are recorded, and errors reported if an update fails. These statistics and logs should be automatically transmitted to a central administrator on a regular basis.

Performance

It is likely that the combined content of providers of e-learning packages, such as Espresso and BBC, will exceed 100Gbytes within the next three years, so a hard drive larger than this should be the minimum recommended for units presently being installed.

The appliance should also be capable of the simultaneous delivery of e-learning content, such as digital video, to many tens of users. A resilient and high performance operating system, such as Linux, would be preferable, as it would also enable more users to be served from an equivalent platform running a Microsoft operating system.

Ensuring a secure e-learning environment

When any internet connection is made, whether for downloading information from sites or just for updating existing e-learning content, security is vital.

As far as internet access is concerned, it is essential that pupils are protected from access to a whole range of undesirable sites. In some cases, bandwidth provided to schools is already filtered to prevent access to generally undesirable sites – by learning grids, LEAs or ISPs such as Easynet. Unfortunately there are now so many potentially undesirable sites that rather than working on a very long list of excluded sites, teachers may prefer only to allow access to a relatively short and manageable ‘include’ list.



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Some products, such as Equinet's CachePilot, offer a very flexible approach with both 'include' and 'exclude' options. This way, if an 'include' only list is felt to be restrictive, teachers can still be reassured by such products' filtering facilities: CachePilot's filtering, for instance, is based on a dynamically changing list of 6 million catalogued undesirable sites.

When it comes to the updating of existing e-learning content sited locally on appliances such as CachePilot, security is once again paramount and a form of digital encryption is needed to ensure the information cannot be tampered with. It is also important that the locally-stored content itself is secured to prevent unauthorized access.

Buying e-learning

Whilst many schools have already bought a great deal of CD-ROM content with their e-learning credit funds (ELCs), many currently lack the technology that enables e-learning material to be delivered - such as caching/content delivery appliances - or the hardware to run it on, like interactive whiteboards. A big opportunity will be missed if e-learning has to be restricted to the ICT suite and is not used with mainstream curriculum subjects.

On the face of it the DfES's 2002 initiative to get nearby LEAs to work together to provide broadband connectivity to all the schools within their area, was laudable. It resulted in 10 Regional Broadband Consortia (RBCs) being established in the UK targeted with networking each RBC and providing 2 megabit connections to all primary schools and 8 megabit connections to all secondary schools by 2006. However, as mentioned above, this size of connection is sadly inadequate for bandwidth-hungry applications unless equipment such as caching/content delivery appliances is also utilized.

Fortunately there is now a big realization in the UK that edge caching/content delivery devices are required, and there is a drive to get the devices into every school before 2006. No single fund has been made available to purchase the devices, but DfEs are



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allowing existing funds to be used, and content providers are often able to offer schools advice on the best approach to be taken.

Who is using caching?

Equinet's CachePilot smart e-learning delivery appliance is used by thousands of schools. It is also recommended by learning grids and LEAs and meets the needs of schools as defined by the Department for Education and Skills and Becta.

The **Northern Grid for Learning**, representing eight LEAs in the north-east of England, foresaw that once schools have broadband, they will want to download multimedia content that will inevitably put a tremendous strain on this new bandwidth. Even with broadband, just five or six PCs simultaneously downloading video-based learning material can clog up the network if measures are not put in place to lessen the strain.

Northern Grid recommended caching/content delivery devices to schools and LEAs in its region. Curriculum-based websites and media rich content services are stored in the local device, based at the school. Content is delivered without need of the internet, and is updated overnight automatically.

Northern Grid's CachePilot devices are supplied pre-loaded with the entire content suite from primary school e-learning specialists Espresso Education. Teachers are also able to pre-cache curriculum based content prior to lessons, enabling them to plan lessons in advance and ensure that Internet access in the classroom is instant, no matter how many PCs are sourcing the same material.

Equinet's CachePilot is also the recommended solution for the London and East Midlands Grid regions, and many LEAs in other regions. It ensures that bandwidth-intensive material is stored locally and updates to the content are sourced at off-peak times.



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Pooltown Junior School in Ellesmere Port, Cheshire achieved a remarkable turnaround thanks largely to the installation of electronic whiteboards, the adoption of caching/content delivery appliances, and the training of teachers to make the most of online resources.

Teacher David Wearing describes the system as 'fantastic' and says that if any of his pupils find a subject difficult to understand, he and his fellow teachers can quickly source a video clip or interactive exercise that explains the subject far more effectively. He says the use of multimedia content on electronic whiteboards engages and encourages children who were reluctant to contribute beforehand. They are much more inclined to raise their hands and take part.

Head teacher Amanda Whitley says that her teaching staff are absolutely thrilled by the more effective teaching that the whiteboards allow. "Our school is in a challenging area and some of our students are capable of challenging behaviour but since the whiteboards were put in our teachers have noticed a marked improvement in behaviour."

Pooltown's experience has been so positive that it is now seen as a county-wide pilot for such innovative teaching methods. Parents, governors and PTA members from other Cheshire schools have visited on numerous occasions to see the system for themselves.

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Top tips to improve e-learning in schools

- Regularly-used websites can be cached or stored, so that when all the children in the computer suite hit the enter button on a new website just one request goes out to the web and finds the site, the others get it straight from the cache.
- Teachers can pre-cache web sites they wish to use later in the day or later in the week. There will be no more worries about whether the web is up or down – that site is ready on the cache.



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- Cached sites can be set up to update automatically – every day, weekly or monthly, day or night, weekday or weekend - so the most up-to-date version is always available.
- School web sites and any online subscription content can be mirrored on the locally-sited appliance, and updated automatically. This means no bandwidth is used when accessing this content, even if it is being used by every PC in the school.
- Media rich teaching and learning content and subscription sites can be preloaded into the appliance. Access and updating is automatic once the school has subscribed.
- The use of digital video content to support teaching and learning was one of the key features teachers were told broadband would make possible. Most have discovered even with broadband, networking online video is disappointing. A caching/content delivery appliance will deliver cached video to a whole suite, simultaneously.
- For schools with small peer to peer networks, delivering CD-ROM content across all machines is a problem and adding a server is expensive. CachePilot makes it possible to store a copy of each CD and, just like a server, deliver the content to all PCs. It can also be set up to provide secure folders for saving pupils' and teachers' work.
- For schools with ISDN at present there is no problem. One caching/content delivery appliance – CachePilot - even has a card fitted and will auto-setup to most service providers. This can then be simply reset when the school changes to broadband.



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- Local web filtering is also provided in some devices – basic ‘include’ and ‘exclude’ lists are provided free in CachePilot, for example, and more sophisticated filtering is already set up in the unit, released when a subscription is taken out with the service provider.

About Equinet

Equinet works with schools around the UK to deliver e-learning content on its smart caching and content delivery device, CachePilot. CachePilot has been selected as the preferred solution by three major Learning Grids and is in use in thousands of schools. It enables teachers to pre-cache required internet sites before lessons begin, ensuring swift access for all PCs during class time. It is also available with content pre-loaded onto the unit – such as that provided by Espresso Education, Pearson Broadband and 4Learning - and contains sophisticated web filtering to block or allow specified web sites and enhance security.