5 Learning technologies

THIS SECTION AT A GLANCE

- we explore the types of technology used in physical learning spaces;

- we identify that both high-tech and low-tech solutions can aid collaborative working;

- we look at some case studies of innovative use of technology in physical space.

Expectations from reading this section

In the context of learning spaces there may be some ambiguity as to what actually constitutes a *learning technology* as opposed to more generic audio visual tools. In this section we take a very broad view of the use of technology to support learning and discuss most of the equipment used in physical learning spaces. If you are looking for specific guidance on visual displays in terms of size, and viewing angles then you will find this in the visual standards subsection within Section 4, Effective learning by design.

We aim to give a broad overview of the main technologies in use and explore some relatively innovative tools in order to inspire readers to try a range of different approaches.

In particular we suggest that:

- whilst teaching in lecture theatres continues to be an important feature of higher education, technology has changed the types of learning activity that take place in these physical spaces;

- BYOD is a game changer in terms of the types of interactivity that are now possible in large cohorts;

- inclusivity still represents a challenge for some technology enhanced learning.

5.1 Rethinking practice with technology

The continued importance of physical learning spaces lies in their being able to support learning activities that could not happen in other ways and technology has an important role to play in this. If we view the format of the traditional lecture as stemming from a scarcity of information sources (the fact that learners had to be physically present to hear from the expert, and the only person who had access to books) then the current abundance of information sources means that access to information is no longer a primary reason for bringing people together, and we need to rethink the types of learning students undertake in these collective situations.

The traditional lecture may be the most obvious example where we need to rethink pedagogy but there are many other situations where technology can help create more effective learning experiences.

There is of course more to this than simply providing technology. We need to ensure that the technologies are appropriate for the types of learning going on in the space; that the user interfaces are simple and intuitive and that lecturers are supported in making effective use of the technology. A number of contributors to this Toolkit reported that some of the technology available in their institutions was underutilised. When we asked why this was the case one answer summed up the issues for many: *"This has to do with tradition, familiarity and some academics thinking it is still 1985"*. It is equally to do with a lack of appropriate staff development and showing people the potential and opportunities. When this happens, many experience a "eureka" moment!

5.2 Examples of technologies used in physical learning spaces

5.2.1 Lecture capture systems

The term lecture capture covers a range of technologies that creates a digital record of what happens in a lecture or class. The simplest form of lecture capture might be an audio recording that can be made available as an MP3 file for students to play back on portable devices. At the other end of the spectrum some universities have a dedicated studio where tutors can record classes for use in online learning contexts (including MOOCs[116]) or blended learning[117].

In this Toolkit we are looking mainly at systems that are used in a typical lecture theatre such as the brands Echo360[118], Panopto[119] and the open source solution Matterhorn[120].

The types of functionality such systems provide typically include:

- administrative tools for scheduling automated recordings, manually uploading files, and managing videos, metadata, workflows and processing functions;

- integration with recording devices in the classroom for managing automated capture of audio, VGA, and multiple video sources;

- processing and encoding services that prepare and package the media files according to configurable specifications;

- distribution to local streaming and download servers and configuration capability for distribution to channels such as YouTube;

> "In fact it is not enough to be different: it should be better than the alternatives. Learners are routinely much more interactive with the material when using books (or handouts) than they can be with lectures: they read at their own pace, re-read anything they can't understand, can see the spelling of peculiar names and terms, ask other students what a piece means, and carry on until they understand it rather than until a fixed time has passed. All of these ordinary interactive and active learning actions are impossible or strongly discouraged in lectures.
>
> So for a lecture to be interactive in a worthwhile sense, what occurs must depend on the actions of the participants (not merely on a fixed agenda), and benefit learning in ways not achieved by, say, reading a comparable textbook." (Dr Steve Draper, University of Glasgow[115])
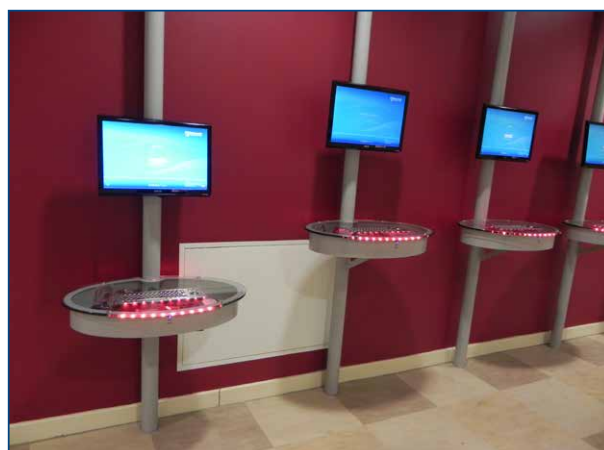
Photo 10: Quick access terminals in corridor spaces at Newcastle University.

115   www.psy.gla.ac.uk/~steve/evs/il.html
116   https://en.wikipedia.org/wiki/Massive_open_online_course
117   https://en.wikipedia.org/wiki/Blended_learning
118   http://echo360.com/
119   http://panopto.com/
120   www.opencast.org/matterhorn

- user interface for learners to engage with content, including slide preview, content based search etc.

A similar type of technology, not covered here, is software such as Camtasia[121] that captures on screen activity such as typing and cursor movements thus allowing the tutor to create an online demonstration with an audio voiceover. The key difference is that standalone software such as this is not integrated with the virtual learning environment (VLE) or scheduling systems and therefore requires significantly more user effort to make a recording available.

Lecture capture offers a number of benefits for students:

- the opportunity to review aspects of the class they found difficult to understand;

- provides a study aid for review and revision;

- helps accommodate different learning styles;

- assists students who have particular educational needs;

- support for students with dyslexia or who do not have English as their first language;

- where video is used this can be useful in reviewing complex formulae written on a board, props used by the presenter or the steps of a demonstrated procedure.

Photo 11: AV pods in the interactive lecture theatres at City University are equipped with a range of learning technologies including: visualiser, interactive pen and digital flipchart.

© City University

To some extent lecture capture formalises something that students will do for themselves if they see a need as it is easy to make poor quality recordings using mobile devices. In the early days of lecture capture there was considerable concern that students would simply stop attending lectures (similar concerns in fact to those raised when tutors started putting lecture notes on VLEs). Our discussion on the concept of interactive lectures and what kind of learning experience the lecture should provide if it is to remain a viable learning activity in the 21st century is of relevance here. It is also the case that watching or listening to a recording does not really take any less time than attending the lecture in person.

Not all lecturers are comfortable about being recorded, particularly on video. The choice of which elements of the lecture to record depends both on the tutor's preference and what is actually being presented e.g. for complex formulae written on a board or for scientific demonstrations the use of video is essential whereas for many other types of lecture, a view of the slides with audio voiceover may give a better quality output. A clear policy is required to support such technology, and this can require a change in institutional mind sets. Loughborough University has a policy for lecture capture[122].

The introduction of such technologies represents an interesting exercise in change management. A pilot study[123] by the University of Edinburgh in 2008/09 produced some interesting results in relation to perception:

- academic staff who were not involved gave lecture capture -5% approval;

- academic staff who were involved gave it +56% approval;

- students gave lecture capture +87% approval;

- 69% of lecturers involved would like to have their lectures recorded again.

Lecture capture makes possible interesting new developments such as the concept of the *flipped classroom* whereby a tutor makes the lecture recording available for students to view in advance so that the class time can be used in interactive discussion about material with which students should already be familiar.

121 www.techsmith.com/camtasia.html
122 Loughborough University Lecture Capture Policy (2015): www.lboro.ac.uk/media/wwwlboroacuk/content/teachingsupport/downloads/Loughborough%20University%20Lecture%20Capture%20Policy%20Jan%202015.pdf
123 www.ed.ac.uk/information-services/computing/audio-visual-multi-media/captured/background

A complication for UK universities is that there is no standard approach to the attribution of lecture content as intellectual property. Some universities view materials produced by lecturers in the course of their employment as the university's intellectual property whereas in other cases ownership resides with the individual lecturer. In either case performing rights may remain with the lecturer so there is a need to establish clear policies on the capture and release of teaching sessions. It is of course also the case that lecture capture serves as a useful reminder to lecturers to ensure they have appropriate copyright clearance on all the materials they use in the lecture.

Newcastle University is unusual in having an opt out policy rather than an opt in policy when it comes to lecture capture[124]. Loughborough University *"strongly encourages the recording of lectures with ReVIEW in undergraduate and postgraduate teaching, for the benefit of both campus-based students and distance learners"*, although recognises that it is not appropriate in all contexts or disciplines.

The University of Derby has tended to emphasise principles rather than a specific policy. The University owns the lecture content but the academic owns the publishing so there is no pressure to put up a lecture if they feel they have had a bad day. Lecturers are also in charge of *takedown* which gives them a sense of ownership. Copyright and IPR are specifically covered in staff development.

Lecture capture is not suitable in all situations (such as group work). Some lecturers remember to turn off the recording when the group work starts but they forget to switch it back on again when they start to speak again.

The existence of significant archives of recorded lectures in turn generates a need for ways of making this information readily usable by students such as the ability to bookmark and annotate sections of lectures. One technology that can help with this is Synote[125] produced by the University of Southampton and available as an open source product. Synote is a web based application that permits the creation of synchronised bookmarks or *Synmarks* that can contain notes and tags synchronised with audio or video recordings, transcripts and slides/images and can be used to find and replay parts of the recordings.

5.2.2 Electronic voting systems (EVSs)

Electronic voting systems (EVSs), also known as personal response systems (PRSs) or clickers, are a classroom based technology which can be used to support learning, teaching and assessment. The technology comprises of a handset, receiver and software to enable the creation of question slides. Commonly the software is available as a PowerPoint add in so that lecturers can use an EVS within a context where they are comfortable. Questions are written in the format of choice e.g. multiple choice, Likert scale or true/false statements and are delivered as part of a classroom based session with as many or as few questions as desired. The lecturer controls the pace of the session and the display of results.

Students can use special handsets, or increasingly their own mobile devices, to give their responses when the polling option is open. Systems such as Turning Point ResponseWare[126] allow an existing investment in hardware handsets to be blended with use of a mobile app or website session on student devices.

EVSs can be used to support a multitude of teaching strategies including:

- simple questions to check understanding and give formative feedback to both students and presenter;

- using responses (e.g. proportion who got it right) to switch what you do next: *contingent teaching* that is adapted on the spot to the group;

- brain teasers to initiate discussion (because generating arguments (for and against alternative answers) is a powerful promoter of learning);

- mediating debates;

- facilitating peer assessment.

Benefits for students include the ability to participate but remain anonymous. This is particularly useful for those students who are less confident, articulate or language-proficient than their peers. It ensures the whole class has an opportunity to engage in learning activities as well as promoting two way interaction between lecturer and student.

124 Newcastle University ReCap Policy 2015-16 (2012): https://teaching.ncl.ac.uk/recap/servicepolicy/recappolicy/
125 www.synote.org/synote/
126 www.turningtechnologies.com/response-solutions/responseware

The other important advantage for students is the speed at which feedback can be delivered for questions with right and wrong answers. This tells students exactly what they are doing well and where they need to revise. The immediacy of the feedback also gives teachers valuable information about class performance enabling them to adjust the session content according to the responses given.

To date EVS has required considerable time and effort to be expended on the supporting infrastructure. The University of Hertfordshire has made widespread use of EVSs[127] which required the following:

- EVS receivers in place in teaching rooms;

- software loaded onto computers in teaching rooms;

- EVS handsets issued to cohorts of students;

- EVS database on which all handsets issued to students are registered along with the name of the student;

- EVS receiver channel sign in every classroom to ensure staff and students know what number the system is operating on;

- cross-campus channel mapping exercise to minimise channel conflict between classrooms (a significant problem in the early days);

- occasional software upgrades;

- centralised processes for procurement, handset registration, user support and for ensuring classroom readiness were all key to embedding the technology at an institutional level.

Experience at the University of Hertfordshire showed that the promptness of feedback is probably the most useful feature for both teachers and students.

However, they also experienced difficulties with the technology including channel conflicts, battery failure and user error (the latter being the most common). Because of these issues the use of EVS technology in summative assessments had certain drawbacks namely:

- an inherent risk of system failure at individual and cohort level;

- causes unnecessary tension and/or anxiety for all concerned;

- can pose significant problems in terms of inclusivity.

Due to these drawbacks the university has shifted away from using this technology in summative assessment, although it continues to be used formatively.

Many other UK universities have made widespread use of EVSs, often adopting different models to manage and distribute the handsets. Two notable examples are the University of Surrey where handsets are borrowed by students, via self-issue, from the library for the duration of a semester, and University College London where a number of the larger lecture theatres have the handsets fixed in the seating positions.

EVS technology has been in use for a number of years now and is probably nearing the end of its life as a separate classroom technology due to the greater convenience of alternatives using a BYOD approach. Given ubiquitous wifi, large numbers of students having smartphones and tablets, and the availability of apps and web based polling, few universities are investing heavily in clickers. Mentimeter[128], Socrative[129], Poll Everywhere[130], Kahoot![131] and Participoll[132] are all apps that work across a range of devices.

127 Jeffries, A. (2011) Introducing and Using Electronic Voting Systems in a Large Scale Project With Undergraduate Students: Reflecting on the Challenges and Successes. University of Hertfordshire: http://uhra.herts.ac.uk/handle/2299/7691
128 www.mentimeter.com/
129 www.socrative.com/
130 www.polleverywhere.com/
131 https://kahoot.it/
132 www.participoll.com/

5.2.3 Web conferencing

Web conferencing permits remote participation in lectures or seminars. A campus based session may be broadcast so that remote students can participate. Alternatively, the remote participant may be a guest expert speaker. Due to geographical considerations Welsh universities and the University of the Highlands and Islands have long made use of these type of facilities to bring in remote experts to teach on parts of courses.

Edinburgh Napier University is using WebEx[133] with overseas students in Hong Kong and is looking at bringing in *captains of industry* to give video lectures. The university emphasises the need to think about the use of technology in relation to building employability skills in students and WebEx is also one of the main systems used in the business world.

A number of Universities are using Big Blue Button[134] which is open source and can be integrated into a VLE. Other subscription services include Blackboard Collaborate[135] and Adobe Connect[136].

5.2.4 Visualisers

Visualisers are effectively digital overhead projectors (OHPs). They allow people to use 3D objects instead of paper e.g. engineers demonstrating circuit boards. Anything under the visualiser can also be captured by lecture capture. When used with lecture capture there may be some issues with the video quality but the results are adequate bearing in mind that lecture capture is mainly intended for people who were in the room to refresh their knowledge and personal experience.

The University of Birmingham found that the technology was being underutilised and held a visualiser workshop to encourage science staff who do a lot of writing to adopt more inclusive practice (so that students can actually see and the outputs can be used in lecture capture).

At Loughborough University they were marketed as digital OHPs as academic staff felt more comfortable with the term rather than using *visualiser*. This aided the process of the withdrawal of OHPs within one week.

5.2.5 Wifi apps

There is growing demand for tools to facilitate wireless projection and collaboration between mobile devices. Tutors want to be able to being able to mirror their iPad and Android devices to the data projector, and apps such as Display Note[137] allow students to login through the app and share their screen with the lecturer who can then choose to broadcast it to other devices. Despite increasing interest in wifi apps there is no single technology that is widely adopted and some institutions have reported difficulties with wireless projection and mobile collaboration over eduroam wifi.

5.2.6 Interactive surfaces

A range of interactive surfaces are in use for teaching and learning purposes ranging from common end user devices such as smartphones, tablets and iPads to more specialist equipment.
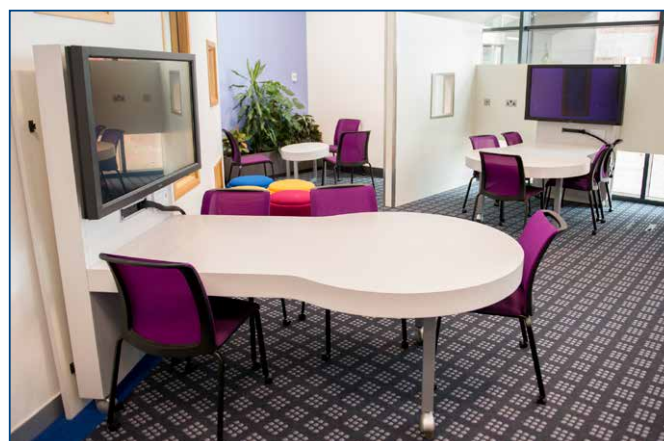

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Photo 12: Technology features heavily in the Learning Curve at the University of Derby.

133 www.webex.co.uk/
134 http://bigbluebutton.org/
135 www.blackboard.com/online-collaborative-learning/index.aspx
136 www.adobe.com/in/products/adobeconnect.html
137 http://displaynote.com/

Interactive whiteboards —are digital screens that connect to projectors and computers. The screen acts as a touchscreen and anything displayed on the board can be saved in digital format. SMART Technologies[138] is a major supplier of interactive whiteboards so they are often referred to as SMARTboards. There is often a big gap in expectations between students who have come from schools where interactive whiteboards are the norm and lecturers who do not know how to use them. They are also difficult to scale up in large lecture theatres. Many universities are moving away from their use except in education subjects where they serve to replicate the school classroom set up.

Multi-touch tables (MTT) —are now commercially available and we are beginning to see their use in learning spaces[139]. As far as we are aware the first MTT developed as a direct result of learning space activities was by the Active Learning in Computing (ALiC) Centre for Excellence in Teaching and Learning (CETL) at Durham University[140]. The CETL focused on problem based learning activities and developed a Techno-Café[141] with high tech booths designed to support students collaborating around a single computer screen. The experiment was highly successful but, even though the technology greatly facilitated collaboration, some interesting observations were made. Even in spaces such as this, it was possible for one student to dominate by taking control of the keyboard, tablet PC or interactive pen. A similar phenomenon was noted at the University of Middlesex[142]. The nature of the technology posed a barrier to equal collaboration so research focused on the use of multi-touch devices to offer equal opportunity for all to collaborate.

Photo 13: Multi-touch butterfly tables in use at the University of Exeter.

The Durham researchers attempted to address the problem by creating a situation where the table itself could act as the interactive display. They effectively invented a giant iPad - in the form of a multi-touch table for up to four users - well before the Apple device was in production. In the period 2009-2013 they undertook extensive research into how students learned using these devices. The work was shortlisted for a prestigious World Technology Award in 2012[143]. Largely as a result of this work, multi-touch tables are now commercially available although bespoke designs may be required to ensure the surfaces are sufficiently robust for use by large numbers of students. The University of Exeter Exploration Lab[144], which opened in 2012, has ten multi-touch butterfly tables. The tables allow up to four users to log on to their own file space in active directory and to share files with other tables. Each table is also connected to a wall mounted display screen to support peer review.

5.2.7 Augmented reality

Augmented reality (AR) integrates digital information with the physical environment in real time by superimposing a computer generated image on a user's view of the real world to provide a composite view. Its uses are currently best known in areas such as enhancing information about tourist attractions but educational use is increasing. Examples include the University of Manchester using AR to enhance the study of medieval manuscripts, landmark editions and modern literary archives[145]; City University using AR in the School of Health Sciences[146] and the University of Exeter using AR to create an information layer for its entire campus[147].

138 http://home.smarttech.com/
139 Multi-touch tables: interactive surfaces built into a table to support collaboration by multiple users.
140 www.dur.ac.uk/news/newsitem/?itemno=6969
141 www.dur.ac.uk/alic/technocafe/
142 http://jiscdesignstudio.pbworks.com/w/page/24184002/ISCC%20Project
143 www.dur.ac.uk/news/newsitem/?itemno=15642
144 https://as.exeter.ac.uk/it/openaccess/exetertable/
145 Special Collections using Augmented Reality to Enhance Learning and Teaching (SCARLET): www.webarchive.org.uk/wayback/
       archive/20140614081239/http://www.jisc.ac.uk/whatwedo/programmes/elearning/ltig/scarlet.aspx
146 https://blogs.city.ac.uk/care/about/
147 www.exeter.ac.uk/students/life/layar/

5.2.8 Writing technologies

We could perhaps have subtitled this section *low-tech technologies* as some of the equipment that best supports collaboration in learning spaces does not have to include a digital component. Writable surfaces in learning spaces are highly conducive to collaboration, participation and active learning. Students often take photos of these outputs and share them via their phone so something that starts in analogue turns into digital.

The Robinson Rooms at The London School of Economics (LSE)[148] were designed to support increased emphasis on group work and research. Magnetic work walls and magnetic paint on structural features were used to create instant opportunities to share and exhibit thought processes. The magnetic work walls can be used as group screens and also work surfaces.

Many universities are now using glass writing boards to create writable walls. The writable glass can be used as dividing partitions in small group learning spaces. At City University[149] the glass is used in breakout areas for the interactive lecture theatres and is often used in conjunction with digital technology to annotate an image projected onto the glass. Glass writing boards can also have drawbacks in learning spaces because they are prone to glare and reflections, especially when students try to photograph the content on the boards. They can also be challenging to integrate with lecture capture solutions as the content on the board is often as important, if not more so, than the digital presentation.

In addition to glass writing boards, many new spaces are being created with glass walls dissolving the inside/outside space and allowing staff and students to see what is happening both in a formal and informal setting. These glass walls are a good writing surface and staff and students should have permission to utilise this additional facility.

More traditional writing surfaces remain useful even in the digital age. Column boards can be custom made and fitted with electric motors to provide a suitable writing surface for the largest lecture theatres. Rail systems allow horizontal sliding of writing surfaces and the combination of flipcharts, writing boards, projection surfaces and pin boards in smaller classrooms. Roller boards can be wall mounted or floor standing.

© University of Derby

Photo 14: Glass writing walls are widely used at the University of Derby.

> **"Write-on and moveable walls** – There are 16 floor-to-ceiling, 1.2 metre wide white panels that move easily on an overhead track and can be locked in place when in position. These can transform the open space to create a series of working areas, projection booths, exhibition spaces etc. Groups can work in their own area using the write-on-walls to visualise their thinking and then push them into position for a presentation to the larger group. Though expensive (approx £1,000 each) these walls have arguably been the most popular and educationally successful elements in the space." (Martin 2010[150])

> "... the technology provision was used to a far lesser degree than expected. When used well it had the capacity to be a powerful support for learning and the creative process, but on the whole, its operation seemed to require more time and trust than most tutors were prepared to invest in, and the most popular use of the technology was the off button." (Martin 2010[151])

148 https://jiscinfonetcasestudies.pbworks.com/w/page/45468872/London%20School%20of%20Economics%20-%20Robinson%20Rooms
149 https://blogs.city.ac.uk/educationalvignettes/2013/03/09/squiggle-glass/#.VeWXzzYVhHa
150 Martin, P. (ed) 2010) Making space for creativity. University of Brighton: http://about.brighton.ac.uk/creativity/Library/UofB_msfc-ebook_FINAL.pdf
151 Martin, P. (ed) 2010) Making space for creativity. University of Brighton: http://about.brighton.ac.uk/creativity/Library/UofB_msfc-ebook_FINAL.pdf

VIEWPOINT

Paul Burt, Learning Spaces Service Owner, University College London (UCL), recognises the diversity of disciplinary needs when it comes to technologies to support learning and teaching. He told us *"There are some departments that don't turn on the E facilities at all: all they want are good writing surfaces"*.

Paul takes a very pragmatic view to making learning technologies as simple and usable as possible because lecturers simply do not have the time to learn how to use a piece of equipment or software. He contrasts higher education with the school environment where a teacher has their own classroom and hence it is worth them investing the time to learn how to use facilities such as an interactive whiteboard that might be provided in the classroom. At UCL Paul is supporting lecturers who might have to teach in any one of 300 different rooms.

Paul maintains that capturing writing will continue to be important for many years to come and he feels there is still an untapped market for products that can capture and digitise a large area of written material as opposed to those that can handle tiny areas in great detail.

UCL has all of its classroom services supported by a single team so AV support is not distinct from IT support. Paul however recognises the importance of specialist AV skills and points out that the trend towards AV and IT convergence has caused problems for many universities. The idea that a general IT person should be able to take on all kinds of AV support underestimates the specialist skills needed as well as the cost to institutions of lost teaching time through technical failure. Paul believes that the static nature of classroom design over a long period of time has contributed to AV being seen as a reactive support role not involved in new developments or having a voice in strategic discussions. Paul can see that it would be equally possible to take a much narrower view of the IT role and say *"If it doesn't have a plug on it then it isn't to do with us"*, but that is not how he views things. Paul prefers to take a holistic view and knows that his job is to ensure the student experience is right in the end.

Resources

- Edinburgh Napier University case study on their use of online collaboration tools[152].

- The University of Hertfordshire undertook a thorough evaluation of its experience with electronic voting systems in 2012[153].

- University College London video on electronic voting systems[154].

- The University of Glasgow interactive lectures website has some good advice on designing questions[155].

- University College London has an extensive resource centre dealing with all aspects of lecture capture[156].

- University College London videos of staff and student perspectives on lecture capture[157].

- This publication by the UK Media-Enhanced Learning Special Interest Group (MELSIG) looks at innovative practice in teaching and learning with smartphones and tablets[158].

- City University has produced some Top Tips for creating augmented reality resources in education[159].

- University of Sussex guide to using interactive whiteboards[160].

152 www.cisco.com/c/dam/en/us/products/collateral/conferencing/webex-meeting-center/edinburgh-napier-university.pdf
153 http://jiscdesignstudio.pbworks.com/w/file/fetch/60025852/EEVSFinalReport%20reportNewFrontpage.pdf
154 www.ucl.ac.uk/teaching-learning/technology/voting-systems
155 www.psy.gla.ac.uk/~steve/evs/qpurpose.html
156 https://wiki.ucl.ac.uk/display/LecturecastResourceCentre/Home
157 www.ucl.ac.uk/teaching-learning/technology/lecturecast
158 Middleton, A., ed. (2015). Smart learning: Teaching and learning with smartphones and tablets in post compulsory education. Media-Enhanced Learning Special Interest Group and Sheffield Hallam University: http://melsig.shu.ac.uk/?page_id=503
159 https://blogs.city.ac.uk/care/
160 www.sussex.ac.uk/tel/learningtechnologies/iwb