Educational multimedia

This document is about **1. Choosing and using** and **2. Designing** for different *digital media* in an *educational* setting. It includes 3. Notes on general **design principles** for learning materials.

You already know how to communicate ideas and help students express ideas of their own. Have confidence in your teaching, and choose digital media that let you - and your students - be creative.

General benefits of using digital media in education

- Easy to distribute
- Easy to work on collaboratively with others (shared documents, annotations etc)
- Easy to re-edit and recombine in different formats
- Students can download, organise and repurpose files to suit their needs (depending on access and format)
- Different sources of information can be connected meaningfully e.g. with text-based and visual links
- Different interfaces supported, so students can access materials as they prefer, e.g. on different devices, using different accessibility and adaptive settings
- Typically cheaper, even on subscription; free and open access digital media are also widely available
- More than one media channel supports better understanding (for most learners)

General considerations for using digital media in education

- **Inclusivity** means including a range of cultural references and examples, and ensuring different points of view are represented, whatever the media chosen.
- **Accessibility** has a range of different meanings depending on the medium. While some pointers are given in the table below, you should always consult up-to-date guidelines to ensure materials can be accessed and used by all students.
- **Source** all digital media with care for copyright issues (can you use it with students?), technical issues (will students be able to access it?), and of course relevance (is it useful to students?).
- Reduce **file sizes** as far as possible without compromising quality. Consider how students can access large files (many will be trying to limit their data usage).
- Media designed for education may include **interactive** features such as quizzes, tasks and links. More sophisticated interactivity might involve feedback in a tutoring style and branching pathways.
- Educational content may be carefully **sequenced** and structured - in fact there are apps that allow teachers to design sequences easily by dragging and dropping elements.
- **Immersive** environments such as games and simulations are highly specialised, and within their design constraints they provide almost infinite options for in-world practice and response.
- However, students may also use **authentic primary content** (not specially designed for learning). Tasks such as research, summarise, critique, analyse, solve, compare etc are given *with* the content, and prompt students to use it interactively for learning.
- Learners should encounter all media **actively**, e.g. by taking notes/annotating, commenting, editing, re-purposing, embedding, linking, analysing. 'Static' media can be encountered in an active way.
- Students learn more deeply when they **produce and present** ideas of their own. You may only need to give them a brief, some examples, and permission to use media and tools of their choice. Discuss issues such as language, purpose and audience, and be clear about assessment criteria.
- Students who study media (e.g. film, photography, literature, digital media) develop specialist **critical skills**. However, all students need and can develop a critical awareness of how digital messages are constructed, how they present a partial view of the world, and how they achieve their effects.

1. Choosing and using digital media for learning

Type	Examples	In learning
Text	Articles, reports, e-books, slides, text-based models, instructions	Text is typically linear, but learners can read at their own pace. Texts are not *only* linear; digital readers must learn to skim read, use an index and word search, compare texts, read abstracts, use tags etc. Most academic ideas are still communicated as text, so learners need proficiency in reading and writing a range of genres, e.g. articles, reports, presentations Many familiar conceptual tools can be applied to text e.g. compare, contrast, interpret, analyse, summarise etc. A range of digital tools can also be applied to text, e.g. text mining, word density count, word trees, concept maps. Texts can be powerfully combined with spatial representations e.g. in diagrams, mind maps, flow charts, tag clouds, density maps, typologies. Basic accessibility for digital text means: sans serif fonts, use 'styles' for headings, good colour contrast, and 'alt' (alternative) text for images. Text is the most accessible choice for students using screen readers.
Image	Photographs, illustrations, diagrams, designs, instructions, infographics	Images are rapidly processed. Images improve recollection and and recall (for some learners). Illustrations support understanding of process, design and spatial concepts. Photographs support understanding of context, and add human interest. Images can be used to stimulate metaphorical, non-linear thinking e.g. associations, feelings, analogies, responses. Students may need to read and produce specialised images, e.g. data visualisations, diagnostic images, maps. All students need to understand the signs, codes, genres, structure and intent of visual messaging - we live in an increasingly visual culture. Basic accessibility for digital images means: good contrast; descriptive tags and alt text when embedded in text or another medium.
Video (moving image)	Videos, video compilations, animations, slidecasts	Video is linear. Learners can play it back speeded up or in segments but it is still considerably less flexible than text. Video is widely used in many sectors for communication; skills in video communication are highly desired in employment. Especially useful for teaching practical skills e.g. use of instrumentation, clinical skills, vocational skills, developing and using software. It is easy for students to consume video passively (and quite difficult to annotate). Encourage reflection, practice (see one, do one), answering questions. As with images, students may need to read specialised video files for data analysis or professional practice. Also as with images, students need a general understanding of how video messages are produced and have their effects. Basic accessibility for digital video means: transcripts available; captions and subtitles; and ideally an audio description of visual content.

Type	Examples	In learning
Audio	Voice overs, podcasts, music, audio books	Voice gives a strong sense of human contact, often better even than video. Audio improves recall (for some learners). Audio + visual channel is preferred by many learners; audio is essential for blind learners and those with reading difficulties. Consider giving audio feedback on student work - saves time and is more personal. Audio allows learners to fit learning into a busy life e.g. on public transport, engaged in repetitive tasks. Research is ongoing as to whether music acts as a distraction or can enhance concentration (it may be different for different students). Dialogue is more engaging than one voice speaking: consider recording short interviews with other experts, asking someone to interview you. Basic accessibility for digital audio means; a transcript and ideally sub-heads/ captions to break up a longer recording.
Data sets	Statistical and other data (e.g. other media); metadata, codes, functions and algorithms	Data is the raw material for (learning how to do) research, analysis, reporting, modelling, creating an evidence base, using scripts, codes and equations. Data literacy is required in many roles, and necessary to be an engaged digital citizen. May contain other media e.g. text, video, links. All data represents a particular and partial view of the world - knowing how data sets are constructed and that they may be biased is critical. Most students benefit from a basic understanding of functions, equations, scripts, codes and algorithms. All students need to understand metadata, analysing and managing data, though this will be specialised to their subject area. Handling data as a medium requires attention to legal and ethical issues.
Immersive media	Games, simulations, models, virtual reality (VR), augmented reality (AR), virtual worlds, virtual patients	These media engage at least visual and auditory channels: they may include haptics and/or spatial orientation as well. Other information may be provided e.g. text, data, links. Valuable for learning clinical and professionall skills e.g. flying a plane, drilling a tooth. Valuable for learning to respond in complex situations e.g. business case studies, disaster simulations. Valuable for discovery learning in complex systems, e.g. virtual experiments, virtual operations, simulations of climate, economy, astronomical phenomena Collaborative gaming environments support communication and collaborative learning as well as discovery/immersive learning. Feedback is instant and intrinsic, leading to rapid associative learning. Immersive learning can happen at a pre-conscious level. Materials are complex, expensive and skilful to develop: teachers more likely to be choosing than building them, so must be able to evaluate their relevance. Students still need tasks to complete and opportunities to reflect and apply their learning - the immersive environment can't be relied on to do it all.
Hypermedia	Any link embedded e.g. in text, image, presentation	Links give other media a wider context. Students need to understand hyperlinks as a form of referencing, and to create their own pathways through complex, interlinked texts. Hypermedia can give an illusion of depth - students must be able to record and reflect on their 'reading' of content and context. Creating hyperlinks can help students learn to navigate a topic area and/or manage references. Students should understand hyperlinks as non-neutral, and appreciate how they organise, describe and interpret as well as simply connecting.

2. Producing digital media for learning

General considerations for producing digital media

- Developing learning materials is time consuming, especially when you do it for the first time, and especially if you adapt your materials every time you run a course (trust me!).
- If you're interested in information design, if you love making professional quality materials, and if you have (or are developing) digital media skills, the time you invest will be well spent. Students love their learning environment to be well designed and their resources visually pleasing.
- However, if you are focused on pragmatic solutions, learning materials just need to be 'good enough' for the intellectual and practical activities they support. Materials you already use such as slides and hand-outs can readily be adapted for digital delivery. Off-the peg templates in every design application you use make it difficult for the results to look less than competent.
- Trust other teaching staff to have done at least some of the work for you. OERs are road-tested materials that are freely available to adapt and re-use. Links to resources are often shared in teaching forums.
- Also: less is more. Blank space, silence on the audio track, the opening sentence, the unlabelled diagram, the unanswered question… all these invite students to engage. Materials become more like *tasks* when they create a space for students to fill with their own ideas and solutions.
- Also: the most unpromising materials can become resources for learning given the right critical perspective. Students can critique, improve or reverse engineer anything, whether it's a video, academic article, or a software application.
- And finally: focus on developing your students' ability to express themselves, academically or professionally, using digital media. Offer tasks and challenges, a range of examples, and assessment criteria that encourage their creativity and originality.

Ideas for specific media

Text

- Basic accessibility for digital text means: sans serif fonts, use 'styles' for headings, good colour contrast, and 'alt' (alternative) text for images.
- Text-based media (including slides) should be easy for students to repurpose, so the format should support commenting and annotating, and ideally re-editing.
- These first two considerations are more important than stylish visual effects.
- Mark different kinds of text such as quotations, references, labels.
- Complex arguments and explanations are usually best presented textually. Help students read long texts by breaking them up with sub-headings, quotations.
- Complex systems and processes can often be best explained with a diagram, though text may still be essential for labelling and providing an explanation alongside.
- If text is your thing, explore how you can use text links and annotations to add depth to a digital text.

Images

- Images often carry essential information e.g. for mapping, diagnostics, or in visual subjects such as architecture and art.
- Images can also be used to provide context, detail, and human interest to almost any subject matter.
- Check you have permission to use an image, and credit the original image maker.
- You can find copyright-free images via subject specialist portals or open source sites such as Wikimedia; consider creating or recreating images yourself if they are critical to a topic you teach.

- Adobe software is industry standard for producing and manipulating images, but most operating systems include basic photo and image processing, and there are hundreds of cheaper apps.
- Diagrams are effective for explaining structures and processes. Labelling a diagram is a useful learning task.
- Experiment with sketching and mind mapping apps to produce illustrations of a whole topic area. Students benefit from trying visual ways of understanding a concept.
- Data visualisations can be produced quickly from charts and data sets - or using dedicated graphics applications. Why not have students produce their own versions and explore how the same data can be seen from different points of view?
- Add links to images e.g. using ThingLink, Sway, to create a richer experience - you can include data, quizzes etc (see interactivity).

Video and audio

- A simple approach is to record video or voice-over alongside lecture slides. For audio, just use the recording function in your presentation software. To add video try screencastify, screenflow, Camtasia or whatever your organisation recommends.
- Record live classes using lecture capture where this is available, or record an online class using the 'record' function in your video platform. In both cases, make sure students have given their permission to be included - consult your organisation's policies.
- To make your own talking-head video or record a practical experiment, an interview, or an event in the field, a mobile device with a small tripod can be just as good as a high end camera. You may need to invest in an external mic to improve the sound quality.
- Most computers have a native application you can use for basic video editing. And as with photo editing, there are cheap apps that provide many of the functions of the industry standard software.
- Rather than making original video, consider curating a number of short videos, or post a video task and have students respond with their own videos (you can curate these using e.g. flip grid).
- Short segments of video content are easier for students to follow and annotate, and for you to record. Consider whether you should provide a transcript or subtitles.

Interactivity

- Quizzes and revision 'flashcards' are relatively simple to produce yourself, and students appreciate these being tailored to their course. Search online or ask colleagues what tools they recommend.
- Some teachers use drag-and-drop tools to create sequences of learning content from simple components. e.g. Pear Deck, Nearpod. Others link different media into an image (e.g. using ThingLink, Sway) or a presentation. New tools are developing all the time.
- If you want to make use of complex interactive environments such as simulations, games, virtual and augmented reality platforms, virtual patients, models of the economy or the environment etc, find out what your organisation has on subscription, or look for open education resources (OERs) via a generic or subject-specialist hub.

3. Design principles for educational media

Many web sites and text books offer principles for designing educational materials. The principles come from a worldview or discipline called '*instructional design*', that is based on supposedly universal principles, often derived from cognitive science and neuroscience. They can be productive as part of a design process and conversation, which always means setting general principles in a specific context. But any claims to universality in design should be treated with caution. First, evidence has usually been gathered from certain kinds of people - often US college graduates - leading to cultural bias. Second, learners differ in their preferences for media, the channels by which they attend and remember, and the kind of material that interests them, even if they share a cultural background. And third, the self-same learner will encounter materials differently in different settings.

We are living through a period of radical change in the media that surround and define us. As we become more sophisticated users of digital media, and as designers become more skilled manipulators of them, our responses change as well. Perhaps the best known example of this is the increasing use of graphics to convey valuable information in contexts that previously were dominated by text. So rather than thinking about digital media as a fixed set of cognitive triggers, it is surely more interesting (and relevant) to think of them as cultural phenomena that are developing, and are constantly open to different readings.

For each set of principles, I've suggested how these could become active questions or prompts for your own design thinking and decision making - always taking into account the larger context of your educational culture, and the more local contexts of your learners and their motivations and needs. Hopefully these will lead you to design thoughtfully and creatively, rather than pursue a fantasy of the perfect instructional product. These questions will still not be relevant in all cultures and settings. When in doubt, ask your students to help you design and develop your learning materials!

Principles	Questions
Mayer's principles of multimedia design 1. Multimedia principle - a combination of text and graphics supports most learners best, especially novice learners 2. Coherence principle - remove any elements that do not contribute directly to the learning (e.g. the concept, method, technique, argument) 3. Contiguity principle - place elements related to the same concept etc close together in time and space 4. Redundancy principle - for most learners, a third media element does not add to understanding 5. Signalling principle - show clearly how information is organised 6. Segmenting principle - present concepts, rules, methods as segments that learners can access at their own time and pace 7. Pre-training principle - introduce key terms and definitions in advance	These principles seem useful for thinking about **design *elements* and how they relate to one** another in a specific topic area. So you could ask: • What **media elements** are available to support learning in this topic area? Do they offer enough **variety**? • Do they support learning through different **channels of attention** (text, graphic, audio, moving image)? • How will students **respond** to different media e.g. through actions, representations of their own? • Can learners **choose** when, whether, how and in what order they encounter these elements? • If not, how should they be **arranged**, linked, grouped or sequenced for learning? • What do students need to know **first** (review and preview, define, situate)? • What do students need to **practice**? • What do students need to focus on and **remember** afterwards?
Merrill's five principles of instruction Learning starts with **real-world problems** that make sense and are motivating to learners. Learning must **activate existing knowledge** and skills, helping learners to connect the new knowledge or skill with existing frameworks Teaching must **demonstrate the knowledge** e.g. through.narrative, image, reasoning, activating different regions of the brain Learners must **apply new knowledge** for themselves: practice, trial, and learn from mistakes Learning must support **integration of the knowledge** through discussion, reflection, use of the knowledge in new contexts	These principles provide a useful **general guide to *ordering* content,** though they are less detailed than Rosenshine's. Perhaps the most interesting questions arise from the first requirement for 'real world' problems'. You could ask: • What kind of problems does this subject equip students to address? • What are the advantages of using *artificially constructed* problems (abstract, generic, 'safe', structured, sequenced etc) in this learning? • What are the advantages of using '*real world*' problems in this learning? (e.g. motivation, need for novel solutions, dealing with unstructured issues)? • How and where can authentic problems be found? How can they be communicated/demonstrated (or can learners encounter them directly)? • What could learners actually do or contribute ('*apply new knowledge*')? • What authentic ('real world') feedback might students get? • How would students know their solutions are making a 'real world' difference? A problem might be 'real-world' in just one sense e.g. it might be based on a 'real' problem but the way learners encounter it might be entirely within a class setting. Or it might be an entirely 'constructed' activity, but real-world feedback could be sought.

Principles	Questions
The ADDIE model of instructional design 1 Analysis — what is the overall goal and what do learners need to achieve it? 2. Design —break the problem down: write learning objectives, choose media and outline delivery methods 3. Develop — create the course according to the design rubric (materials, tasks, assessments) 4 Implement — deliver the learning with any on-course adaptations needed 5. Evaluate - assess the impact and outcomes for learners	This model does not relate to any specific aspect of design but outlines a professional process very similar to the **reflective practice** cycle that Douglas Schön recommends for all teachers, in all settings. This involves trying new approaches, observing learning in practice, reflecting, and drawing conclusions. Rules or rubrics for design matter less than *conscientious reflection*, *careful observation* and *questioning* learners about how they are engaging with new materials.

3. Further reading

List of apps for producing learning resources
Mayer's principles of instructional design
Comparing Universal Design with Traditional teaching (schools based but still useful)
Getting started with accessibility
Web accessibility from W3C
Using digital media in new learning models
OER commons for Open Educational Resources of all kinds
WikiMedia commons for open source media of all kinds