Practical Recommendations on the Production of Video Teaching Resources.

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Abstract

Instructional videos are widely used and potentially highly effective and flexible teaching tools. They are increasingly employed in practical skills training in the fields of science and healthcare. However, educators may struggle to source suitable videos demonstrating safe and suitable techniques. In addition, academic staff may lack the resources and expertise needed to produce and edit effective video in-house. This article provides an overview of the planning, shooting, editing and sharing of video footage to produce effective teaching resources. The aim is to provide guidance for academic staff who wish to develop customised teaching videos and successfully integrate them into their teaching.

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1. Introduction.

Instructional videos are a widely used teaching resource. They have been reported as useful and engaging learning tools in veterinary, science and nursing education (Kelly, Lyng, McGrath & Cannon, 2009; Roshier, Foster & Jones, 2011; Allavena, Schaffer-White, Long & Alawneh,

2017; Terry, Terry, Moloney & Bowtell, 2018) and have been integrated into teaching and assessment in a wide variety of ways. Advantages of their adoption include (but are not limited to) their flexibility (Berk, 2009; Klupiec, Pope, Taylor, Carroll, Ward & Celi, 2014; Chuang, Lai, Chang & Wan, 2018), acceptance by students (Hawkins, Hansen & Bunch, 2003; Chan, 2010; Grynberg, Thubert, Guilbaud, Cordier, Nedellec, Lamazou & Deffieux, 2012), a means to provide effective formative, summative and self-assessment (Paul, 2010; Hu, Tiemann and Michael Brunt, 2013; Bree, 2017b; Phillips *et al*., 2017), value as practical skills teaching and revision aids (Hibbert, Lambert, Carter, Learoyd, Twigg & Clarke, 2013; Rowse, Ruparel, Al Jamal, Abdelsattar, Heller & Farley, 2014; Dunne, 2015; Massey et al., 2017), support of blended, online and distance learning courses (Kelly *et al.,* 2009; Holland, Smith, McCrossan, Adamson, Watt & Penny, 2013; Sowan & Idhail, 2014; McIntosh, Patterson & Miller, 2018), flipped classroom teaching tools (Foon & Kwan, 2018) and error training with the aim of improving performance and patient safety (Gardner, Abdelfattah, Wiersch, Ahmed & Willis, 2015). Videos may also aid the integration of the principles of Universal Design for Learning (UDL) into educational resources by facilitating multiple means of engagement (AHEAD, 2017; CAST, 2018).

An area where video has made an impact has been in assisting students to better prepare for practical classes and laboratory work (Dunne & Ryan, 2012; Dunne, 2015; Meade, Mac Raighne, Gregan, Naydenova & Pedreschi, 2015; Agustian & Seery, 2017; Bree, 2017b). Generally, the effective utilisation of video has been found to motivate student learning and capture their attention (Whatley & Ahmad, 2007; Norman, 2017).

1.1 Challenges with Video Engagement.

Despite these advantages, educators may face challenges when it comes to the successful sourcing of suitable videos and their integration into teaching. Videos are widely available from online sharing and streaming sites such as YouTube or Vimeo. However, searching online for suitable resources is time consuming and many of the available clips may utilise unfamiliar terminology or equipment, reinforce incorrect techniques or demonstrate unsafe or undesirable practices (Duncan, Yarwood-Ross & Haigh, 2013; May, Wedgeworth & Bigham, 2013).

Producing in-house videos avoids these drawbacks but it requires some technical knowledge and equipment, and can also be time-consuming (Sowan, 2014). Educators consistently cite time constraints, along with a lack of resources and/or training, as the main barriers to the development and adoption of new teaching tools (Brownell & Tanner, 2012; Blickenstaff, Wolf,

Falk & Foltz, 2015; Y1Feedback, 2016a; Schiekirka-Schwake, Anders, Von Steinbüchel, Becker & Raupach, 2017; Farrelly, Raftery & Harding, 2018; McAvinia, Ryan & Moloney, 2018). In addition, once a video is produced, it may be difficult to subsequently revise or update it. Mistakes, omissions or the presence of distracting or irrelevant objects may require entire sequences to be reshot, much to the frustration of those involved (Norman, 2017). Finding ways to streamline video production and produce resources that can be reused without the need for multiple updates is therefore vital for academic staff engagement. Some institutions have dedicated studios and multimedia production departments to assist staff in producing instructional videos. However, many educators lack such supports and may need to create videos with whatever equipment and resources are available to them. The advent of digital cameras and smartphones has ensured that suitable equipment and software to shoot and distribute video clips are now widely accessible.

1.2 Evidence Base for Technology-enhanced Learning.

There is a growing evidence base for the inclusion of technology in teaching and Higher Education (European Commission, 2011; National Forum for the Enhancement of Teaching and Learning in Higher Education, 2015; Y1Feedback, 2016b; Redecker, 2017). However it is important to consider the relevance and merit of its inclusion for each teaching aid or assessment as opposed to adding ‘bells and whistles’ to modules (Light, Calkins and Cox, 2009). With regard to video and a particular project, it is also important to consider if this media represents the most appropriate teaching tool to use, to avoid wasting time and resources developing unsuitable videos (Roshier et al., 2011; Norman, 2017).

This article aims to provide some practical tips and recommendations on the efficient production of video teaching resources for science and healthcare educators. Engaging with these recommendations will hopefully reduce learning time for staff and provide awareness of the technical aspects involved.

2. Video Planning and Preparation.

Time spent in planning the video content and availability of personnel, as well as considering the equipment to be used, filming location and the editing and distribution processes will help to avoid problems during the production of educational videos.

2.1 Consensus on content.

It is important to clarify from the outset what exactly it is that each video is intended to demonstrate. Consult all staff involved in the delivery of the content or skill to be shown in the video to ensure there is general agreement on the techniques and materials included. Norman (2017) points out that such collaboration potentially reduces staff time commitments as well as producing more relevant video content. Veterinary students identified demonstration of correct technique and reduction in staff variation in teaching as benefits of video exemplars in a UK study (Roshier, *et al*., 2011). The participants in this study reported a desire for video demonstration to set a "gold standard" and expressed frustration if educators taught multiple methods. Nursing students also welcomed video clarification of the correct way to perform skills during assessments (Holland, Smith, McCrossan, Adamson, Watt & Penny, 2013; Massey *et al.*, 2017). However, there may be many ways to successfully perform a technique and educators may have strongly-held opinions on what is the optimal method. If consensus cannot be reached, consider demonstrating more than one technique in the video, along with clarification for students that they are equally appropriate and acceptable alternatives (Roshier *et al*., 2011).

2.2 Scriptwriting and Planning.

Careful planning of the video content and script is critical and it is worth spending some time on this step to avoid pitfalls during filming and editing. Review course manuals, associated literature and textbooks to identify the steps in each procedure to be filmed. This process justifies the evidence base for the steps to be included and also helps to clarify the equipment that will be needed for each video. The use of checklists or standard operating procedures for the task to be demonstrated avoids steps being inadvertently omitted e.g. the need to check or calibrate equipment before performing an analysis. Ensure such records are kept on file so they can be easily referred to in future. This will help promote a standardised and more efficient inter- and intra-departmental approach to filming over time.

Aim for consistency and best practice compliance in attire, protective clothing and equipment to be used in the video. For example, if shooting in a biological laboratory, the demonstrator should wear a well fitted, clean and fully fastened laboratory coat, disposable gloves, eye protection and ensure long hair is tied back. The standardisation of equipment and clothing also facilitates minor updates by allowing footage from several shoots to be seamlessly edited together.

2.3 Keep Videos as Short as Possible.

The longer the video, the greater the risk of the viewer's attention wandering. Five to 20 minutes duration has been identified as a common recommendation (Norman, 2017). A recent study of 1305 North American undergraduates indicated a strong preference for much shorter instructional videos (1.5-3 minutes duration), with videos of more than four minutes in length highly unlikely to be watched unless they were a mandatory course requirement (Clossen, 2018). Both this study and that of Roshier *et al*., (2011) found that the inclusion of a duration indicator that was visible at the start of the video greatly increased the likelihood of it being watched.

Shorter videos also offer several advantages to educators. It is faster and easier to film a task without stumbles or errors when it is broken up into several steps, resulting in multiple brief clips. These short clips will also upload for sharing online more readily and it is much more straightforward to re-record a brief sequence if an error is noted or updates become necessary.

Narration has been found to better promote learning than on-screen text alone so it is important to plan in advance what key information is to be conveyed (Clossen, 2018). Avoid recording lengthy and static introductions where the demonstrator explains what they are going to do. Such material tends to make for unengaging viewing and is unlikely to be an efficient use of the time taken to produce it. Context can be more easily and effectively provided in the form of written or verbal instructions. Norman (2017) points out that this approach also reduces the likelihood of the introduction referring to specific classes, modules or assessments, thereby ensuring the video remains applicable to as wide a variety of teaching situations over time as possible.

2.4 Ethical Considerations.

If people are to be included in the videos it is vital to obtain signed permission/consent to film them and to make the resulting footage available for teaching purposes, including online. Relevant legislation such as the general data protection regulation (GDPR) provides guidance here (The European Parliament, 2016), along with the policies of each educational institution. Copyright issues may also be infringed if photographs or illustrations are included without the correct licence. Individual disciplines may also have specific guidance policies, such as the General Medical Council's policy on patient recordings (General Medical Council, 2013). Sowan (2014) emphasises the importance of considering data protection from the outset, so that consent is actively obtained and recorded before filming takes place.

2.5 Preparation for Filming.

Prepare a list of all the items that will be needed to both perform the task and record it. Gather the equipment in advance and check everything is in good working order, with any batteries fully charged. If filming in a classroom or laboratory it may be necessary to book the area in advance, to ensure availability. Filming often takes place outside of the teaching semester due to the increased availability of personnel and space. However, this time period is also when maintenance or repairs may be scheduled so it is worth checking with the campus maintenance team to avoid scheduling filming during planned power outages or noisy building works.

Table 1 Key points when planning videos.

Seek staff consensus on the method(s) to be filmed.
Clarify the sequence of steps needed to show the key content.
Standardise clothing and equipment.
Aim for several short clips rather than one long video.
Consider ethical issues and obtain necessary consent/permissions before filming.
Gather and prepare all equipment and confirm the venue beforehand.

2.6 Equipment.[1]

Digital cameras work by capturing images on a light sensor and transferring them to a removable storage card. A wide variety are available so it is a question of finding what works best, as the most suitable camera may not necessarily be the most expensive. Rental is also an option if equipment is only required occasionally; contact local camera dealers or online rental providers.

2.6.1 Smartphones and tablets.

Smart devices can record high definition (HD) video footage quickly and easily. The file can be uploaded to a video-sharing site such as YouTube or Vimeo straight from the device. There are numerous editing apps available for smartphones and tablets, enabling the addition of

[1] Cameras are discussed in detail in the sections below. Photographs are included for illustrative purposes; they do not imply endorsement of a particular brand or model.

titles,voice-overs and other effects to the footage.

Phones and tablets have smaller light sensors than a dedicated video or still camera. The resulting reduction in image sharpness may be notable if recording in dim lighting. Many smart devices also lack an optical zoom (this adjusts the lens to close in on the subject, without loss of image quality). Without an adjustable lens, the camera can only zoom in digitally (by cropping the image), which rapidly results in blurry or pixelated footage. The inbuilt microphones are also quite basic. These may be adequate to pick up conversation or close-by sounds, but a dedicated external microphone will consistently outperform an inbuilt microphone.

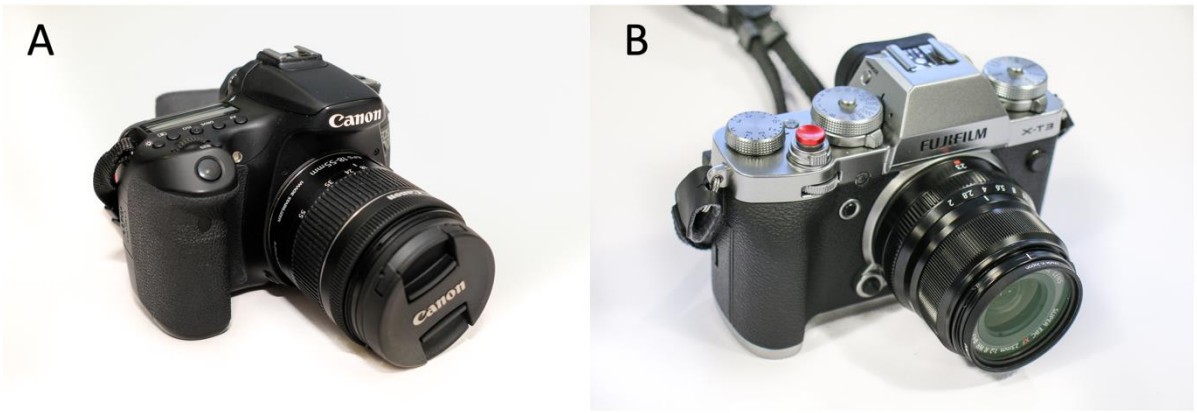
Consider screen orientation when filming using a smartphone or tablet. To make full use of the sensor, hold the device with its long side horizontally (landscape), rather than vertically (portrait). This avoids having black bars appear on either side of the footage when it is viewed on a computer screen or TV monitor and results in a more natural and comfortable viewing experience. Tablets and smartphones display the footage on a liquid crystal display (LCD) screen. These screens may be hard to view when recording outdoors or in brightly lit areas. The device should have a fully charged battery and plenty of free memory space to ensure all necessary footage can be captured.

2.6.2 *Digital cameras.*

Originally, digital cameras either shot still images or recorded both sound and video (camcorders). However, most digital still cameras now also function as HD camcorders and are widely used to capture still images and video footage. That said, dedicated digital camcorders remain easy to use, with good quality built-in optical zooms and excellent battery life, so if available they may negate the need to purchase additional cameras.

There are several types of digital camera available: compact (also called point and shoot), single-lens reflex (SLR), mirrorless, and full-frame. Compacts are the smallest cameras of the group and typically lack a removable lens. The other cameras all have the option of removing and exchanging lenses. For the purposes of making educational videos any of these camera types will be effective and the standard or ‘kit’ lens that the camera is sold with will be suitable in the majority of cases. Most cameras include face detection software, which helps ensure the subject remains in focus while facing the camera.

Figure 1: Digital SLR (A) and mirrorless (B) cameras.



Action, or point of view (POV), cameras are small cameras that come with a housing that can be attached to the wearer's head or body or attached to objects (Figure 2). They are rugged, waterproof, affordable and durable, facilitating filming outdoors or in conditions that could destroy a standard camera. An additional advantage is the finding that students may find instructional videos taken from the operator's head position or face to face position more helpful, rather than the position of an onlooker (Katsioloudis, Fantz & Jones, 2013). Such first-person POV recordings were reported to add an engaging sense of realism to a series of short paramedic training videos (Lynch, Barr & Oprescu, 2012). The variety of mounting options available for POV cameras facilitates filming from these positions, avoiding the need for a separate camera operator.

Figure 2: An action camera within its protective housing, alongside a body harness mount and an extendable handheld mount.

Action cameras have wide lenses to reduce their size and minimise image shake. However, such wide-angle footage may have significant perspective distortion ("fisheye effect"). This can be reduced by adjusting the camera settings during filming, or while editing the footage.

Figure 3: Smartphone mounted on a gimbal

Practical tip: before shooting with a digital SLR camera on a tripod check that image stabilisation is turned off. This setting is designed to reduce shake when the camera is being handheld but may be counterproductive when on a tripod.

A gimbal is a pivoted support that allows the camera to rotate around a single axis (Figure 3). A tripod is a three-legged frame used to stabilise and elevate a camera (Figure 4). Gimbals enable smooth movement while tracking a moving subject for example. A steadycam is a body mount that isolates the camera from the operator's movements. Having the camera on a stable mount enables the shooting of smooth footage that looks far more professional and is much easier on the viewer's eye than shaky, hand-held video.

Some gimbals have an additional movement-tracking feature, which can be useful if recording footage of a moving subject. Once this feature is activated the camera will automatically rotate to follow the subject's movements. This device can track the person in the frame as they move - removing the need for a second person to assist with video recording.

Tripods come with a detachable plate which screws onto the base of the camera, allowing the camera to be attached securely (Figure 4). The tripod head can be moved from side to side (pan) or up and down (tilt) to create more engaging footage, or just to make sure that what is being shot stays in view. Small free-standing tripods are also available. These will support a smartphone or allow a digital camera to be placed on a table without the table surface being visible at the bottom of the shot.

2.6.4 *Microphones.*

Investing in an external microphone ('mic') will improve the quality of video sound, especially if the subject is to be more than ten feet away from the camera. There are three common microphone types: handheld, boom and lavalier.

Figure 4: A DSLR camera with a boom microphone mounted on a tripod, ready for filming.

Handheld mics are not generally suitable for teaching videos as they tend to distract both the person in front of the camera and the viewer. Boom mics can be either attached to the camera (Figure 4) or held overhead and just out of shot on a pole. The latter requires an additional person to assist with filming. Small boom mics that attach to the camera and plug into the

headphones jack are a good starting point. Lavalier mics (Figure 5) are very small and can be attached to the wearer's clothes. They are a good investment if the plan is to record a lot of interviews or the camera needs to be positioned more than a few feet away from the subject.

Figure 5: Wireless lavalier microphone (left) and camera-mounted boom microphone (right).

2.6.5 *Memory cards.*

Modern digital cameras store recorded images/footage on memory cards. There are two main types: standard digital (SD) and compact flash (CF). SD cards are amongst the most widely used and are also available in smaller versions for mobile phones, such as miniSD and microSD. The SD card capacity refers to the amount of data a card can hold. Standard capacity (SDSC) is up to 2GB, high capacity (SDHC) are 4-32GB and extreme capacity (SDXC) versions are now available that can store up to 2 terabytes (TB).

CF cards are widely used in digital SLR cameras. Again, newer cards can hold up to 2TBs and are available in four "speeds" (normal, CF High Speed, CF 3.0 and CF 4.0). In this context, speed refers to the amount of time it takes the card to "write" or store the data after each shot.

Figure 6: Examples of miniSD, SD and CF memory cards.

A practical starting point is to buy two cards for the camera to be used, each with the most memory that the budget allows. Once the footage has been downloaded from the card onto a computer or storage device the card should be formatted. Unlike merely deleting the images from the card, formatting ensures that all the old data has been removed and reduces the risk of data corruption and card reading errors (Carucci, 2013).

2.6.6 Equipment protection and storage.

A padded equipment bag is recommended to protect the camera during storage and transport. It should be big enough to comfortably hold the camera plus spare lenses, batteries, charger etc. Leave a microfibre cloth in the bag to clean the camera lens before each use. Plastic, see-through storage boxes are useful for cables, microphones and other equipment. Make a list of the contents and stick it to the box so that all equipment can be checked before leaving the shooting location.

3. Production (Filming).

Having invested time in the planning of the video shoot and preparation of the equipment, it is important to consider factors such as background noise, lighting and the camera settings and positions to facilitate the capture of good quality footage on the day of the shoot.

3.1 Filming Location.

Ensure the filming location is bright and well-lit, with minimal extraneous background noises e.g. computer cooling fans, traffic, air conditioning units etc. The background should also be free of visual distractions. It is a good idea to record some test footage to check for problems with the

location before commencing filming.

> **Practical tip:** it is helpful to put up some temporary signage in the vicinity of the shooting area to let people know that filming is taking place and not to enter the location at certain times.

3.2 Camera Settings.

Check and select the camera settings before shooting begins, as a previous user may have adjusted them. It is useful to make a note of the settings used on the day as they may be helpful to refer to during the editing process and subsequent recordings. It's obviously possible to get very technical with camera settings but there are two main ones to be aware of:

- Frame rate
- Frame size

3.2.1 Frame rate.

Frame rate refers to the speed in frames per second (fps) at which the still images that constitute the video footage are shot. 25-30fps is typical and is suitable for playback in real-time. Higher rates (50fps and above) allow the footage to be played back smoothly in slow motion but increase the file size (as more images are being recorded per second). Footage of >30fps may also appear slightly unnatural to the human eye during playback at normal speed.

3.2.2 *Frame size.*

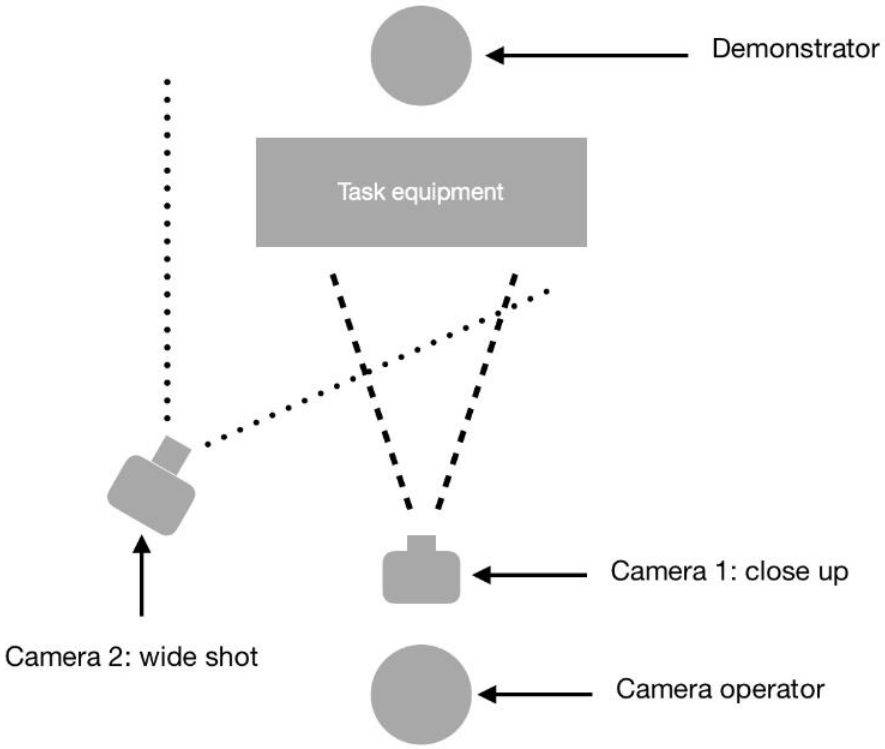
Frame size refers to the screen dimensions and is measured in pixels (px). Common sizes include standard definition (SD) 640x480px (4:3 aspect ratio), high definition (HD) 1280x720px (16:9 aspect ratio, or "widescreen") and 1920x1080px (also 16:9 aspect ratio, sometimes called "full HD"). The higher the frame size the larger the resulting file size. Modern devices may record at resolutions of 3840x2160px for "4k" or ultra-high definition (UHD) footage but not many playback devices have a screen resolution that can go this high (for now). Consider the devices the target audience will be using to view the video on, as this can help determine the frame size required. 1280x720px is a commonly used frame size that results in sharp HD footage without overly bulky files.

> **Practical tip:** the higher the frame size used, the less recording time available on the memory card. Note the recording time remaining on the camera's LCD screen before commencing filming.

3.2 Filming the Task.

A very effective, yet simple to apply approach is to record each scene simultaneously with two cameras from different angles if possible; one for close-ups and the other for a wider perspective (Figure 7). This saves time and ensures a variety of shots are available to demonstrate each task to the best effect. Record each step separately rather than performing the task from start to finish continuously. This allows the demonstrator to refer to the script or task sequence as they go, ensuring each step is performed correctly and as planned. Also, errors are an inevitable part of every shoot, so this approach ensures only a short piece of footage has to be reshot each time.

Figure 7: Simple two camera set up. Note that camera 1 is not visible by camera 2. The optical zoom on camera 1 is used to obtain the close up.



3.2.1 Lighting.

Ideally the subject should be facing the primary light source at a slight angle (the sun if outdoors, lights if indoors). If the light is behind them the subject will appear dark (backlit), while a light source front and centre may make the face look flat (by reducing shadows). In addition, it could dazzle or distract the person being filmed. Bright white surfaces reflect light while dark colours

absorb it, so avoid filming dark items of equipment in a poorly lit room for example. If very dark shadows are being cast onto the area of interest (such as in bright sunlight or under intense artificial lighting), placing a white or reflective surface (improvise with a large sheet of paper or a white sheet etc.) on the edge of the shot can bounce light into the shadows to soften them. Avoid filming on reflective surfaces, such as medical trolleys or stainless steel surfaces, as glare is likely and it will be challenging to obtain clear footage.

3.2.2 Close ups.

It is important to ensure the viewer of a training video obtains an unobstructed view of the procedure. A common error is to shoot footage where other equipment or the operator's hand position blocks the view during critical steps (Roshier, *et a*l., 2011). Solutions include raising the camera to facilitate visualisation over the subject's hands or using a head or body mount to obtain a first-person POV. Review the footage as it is recorded to ensure that the task is clearly captured in its entirety.

3.2.3 Extra footage.

It is extremely useful to take a few minutes when things are set up to record some additional footage of the equipment being demonstrated and the environment in which the task is being performed. This supplementary footage is referred to as the "B roll" or "cutaways". Some of it can be inserted into the video during the editing process. For example, if the video narrator refers to a specific piece of equipment some footage or a still image of that item can be inserted into the video at that point to clearly illustrate it. Adding shots in this manner also makes the video more engaging for the viewer as it can break up the monotony of videos recorded from a single viewing angle.

3.2.4 *Camera operator.*

Before shooting, take some time to ensure the person who is operating the camera and tripod etc. is familiar with the equipment settings to be used e.g. starting and stopping recording, focusing the image, moving the tripod smoothly, using face or movement tracking functions etc. It is also very helpful if they are acquainted with the task being recorded, as they will be able to anticipate the sequence of steps and predict the operator's movements. This avoids jerky and distracting camera moves and reduces the likelihood of task details being missed. Finally, prior to packing away the equipment, check the footage for quality and ensure all necessary steps have been accurately captured to fully demonstrate the task.

4. Postproduction (Editing).

This aspect of video production involves taking all the footage that was captured during the shoot and refining it into a logical sequence that clearly illustrates the task or process to students.

4.1 Software Selection.

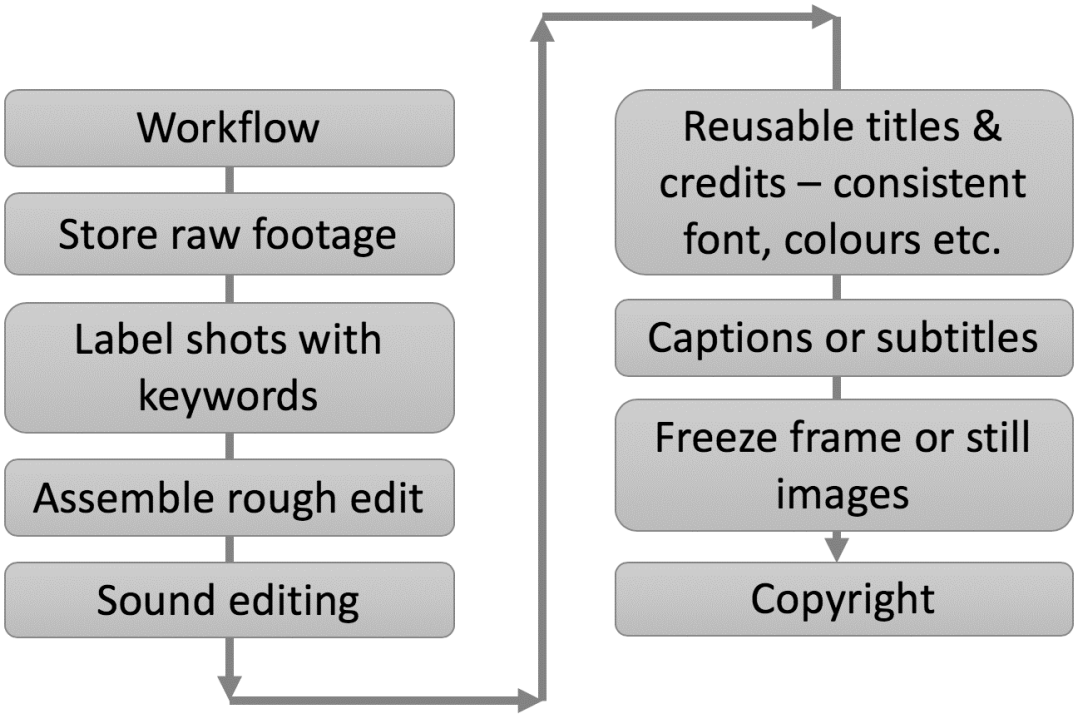
Immediately after the shoot, download and back-up the footage to an external hard drive. From there it can be imported into the editing software to be used. A wide variety of editing programmes are available and it is a case of deciding what is most suitable from the options on the market. Many of the premium software programmes, such as Adobe Premiere Pro or Final Cut Pro X, offer educational pricing or may be included in a software bundle that institutions already subscribe to. There are also numerous videos editing apps for smartphones and tablets. Some examples of these include iMovie (iOS), Cameo (iOS), Cyberlink PowerDirector (Android), VideoShow (Android) and Adobe Premiere Clip (Android and iOS) or Rush CC (iOS).

It is generally easier and more effective to edit footage on a computer rather than a mobile device, so this article will primarily focus on the use of desktop editing tools. Bear in mind also that running these software packages and editing footage ideally requires a computer with upwards of 8GB of random access memory (RAM), a 2GHz dual core processor, 8GB of storage space and a graphics processing unit (GPU) with 8GB of video RAM (VRAM). A typical office desktop computer with the above specifications will not provide a lightning-fast editing set up, but should be adequate for most projects. Trying to edit HD footage on a low specification computer or one more than 3-5 years old is likely to be a slow and frustrating experience.

4.2 Editing process

A typical editing workflow incorporates numerous stages (Figure 8). In essence this process involves merging all the footage needed into one continuous video, as well as adding any additional features, before exporting the video file or publishing it directly to an online streaming site for viewing.

Figure 8: Editing process overview.



4.2.1 Importing, organising and backing up footage.

Begin by importing all the video clips from the camera(s) onto a computer or hard drive for storage and editing. It is tempting to get straight into editing at this point but organising the media files at the outset will save time and effort later on. It is helpful at this stage to place all the clips relating to one project into a folder which is named for that project. Clips may be further subdivided at this point by camera, date or type of footage (wide shots, close ups, still images or B roll footage for example). Once all the footage has been transferred and sorted, it is a good idea to back it up before reformatting the memory cards. The footage is valuable so make and store copies, either on a second external hard drive or a cloud-based server, bearing in mind that uploading HD footage online may take a long time without access to a high-speed internet broadband connection.

4.2.2 *General editing layout.*

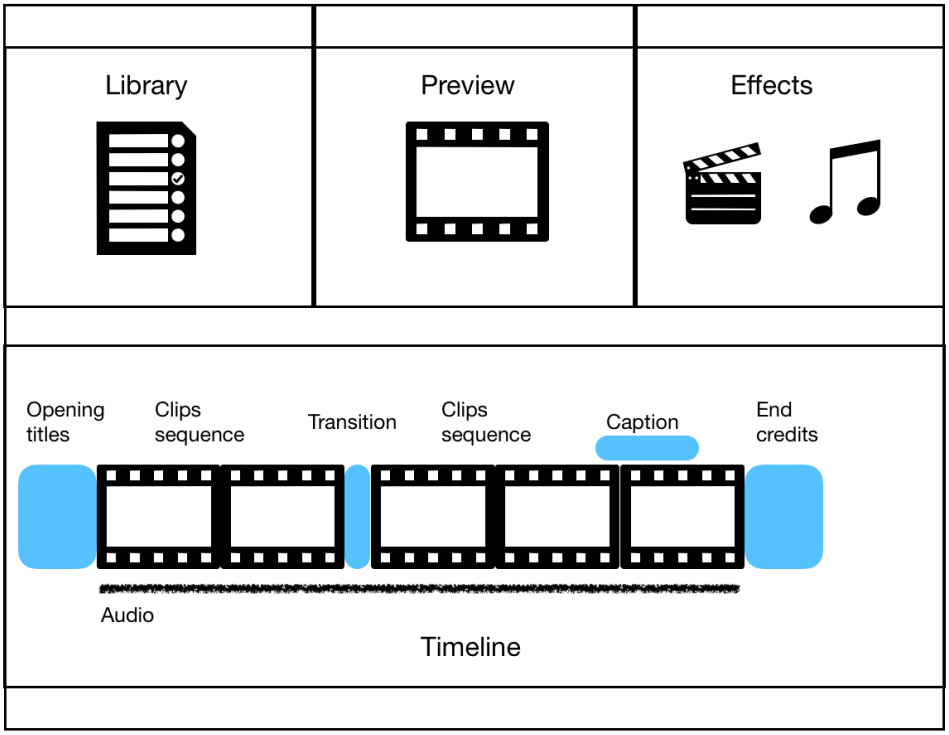
The vast majority of editing software programmes have a similar basic layout (Figure 9). The top left section of the screen is known as the library, bin or browser, where clips, still images,

audio files etc. are displayed, ready for use. Below this is the timeline editor; this is the area where clips are placed in the order in which they will appear in the final video and trimmed to the desired length and content. The preview or canvas window (top centre or right) plays what is currently selected in the timeline. The effects window is also usually displayed as a pop out menu(s) on the right of the screen, from which effects such as titles or transitions can be applied to the footage.

4.2.3 Basic editing workflow.

Create a new project within the software and import the relevant clips to the library, ready for editing. Replicating the folder naming system within the editing software library will help keep everything organised. It may be helpful to label each clip with one or more descriptive keywords. These can be searched and are a useful way to rapidly locate the desired footage, especially in the case of a large number of clips. It is preferable to edit using the same frame rate and frame size that the footage was shot with.

Figure 9: Typical layout of video editing software.



> **Practical tip:** many editing programmes automatically save the file every time a change is made. Nonetheless, get in the habit of saving the work frequently. This avoids the frustration of recent edits getting lost or discarded.

Begin to assemble the initial "rough cut" of the video by placing clips from the library into the timeline in the desired sequence. To reorder clips simply click and drag them to a new position. Trimming tools allow only the relevant footage to be used by marking the desired start and end ("in" and "out") points on each clip, to shorten or lengthen it. However, the trimming and other editing tools do not alter or delete the original footage: they only adjust the copy that has been added to the timeline. This is known as non-destructive editing and it encourages creativity, as various edits can be tried without losing any raw footage. Most software also includes an undo tool, allowing any undesired changes to be quickly reversed.

> **Practical tip:** locate a list of keyboard shortcuts for the editing software in use. They are often a faster and more accurate way to edit than using a mouse or trackpad.

4.2.4 Adding effects.

Once the clips are arranged in the desired sequence they can be refined into a final version. Transitions are used to blend two clips together, such as a fade through black. To apply one select it from the effects menu and then drag and drop it between the two clips where it is to appear. A few well-chosen transitions can give the final video a professional feel but avoid overuse as they can be distracting. Text effects allow titles, captions and credits to be added. Again, select and drag the effect to the desired location on the timeline. Numerous additional effects are available, such as slow motion, colour correction, image stabilisation and animations to name just a few. Refer to individual software packages and tutorials for more details.

> **Practical tip:** duplicate the rough cut and rename it e.g. "teaching video 1 version 2" before starting to edit the finer details. This ensures a backup copy is available if necessary.

It is preferable to standardise the choice of fonts, colours, sizes and logos etc. as much as possible. This will not only save time but also creates a repeatable production style across the entire video library, resulting in a more structured and cohesive learning environment for

students (Norman, 2017).

4.2.4 Audio adjustment.

Sound editing is a whole discipline in itself. However, paying attention to some basic sound editing concepts is an effective way to produce videos with a professional feel. Poor quality audio is very distracting. The audio effects can be used to add music and a voiceover, sound effects or narration to the video, in addition to altering the audio recorded during shooting. The sound quality and volume can be adjusted, either for the entire sequence or selected sections. The editing software will display audio meters and as a general rule any dialogue or narration in a video should be at about -10dB most of the time (Mannion, 2018).

Fading the audio in and out at the start and end of the video creates a more polished “feel” to the finished work. Most software packages also allow the editor to at least partially correct or fade out distracting background sounds, such as passing traffic, the hum from air conditioning units or banging doors. Bear in mind however that software correction can only do so much: it is important to use a good quality microphone and shoot in an environment that is as free from extraneous noise as possible.

If music is to be included it should be royalty-free. There are numerous suppliers of such tracks that stipulate the terms and conditions of their use e.g. freemusicarchive.org, songfreedom.com or smartsound.com. For example, the author/composer may need to be credited onscreen while the music is playing, or in the end credits. If adding a voiceover ensure that the narrator speaks clearly and slowly and that the timing of the narration corresponds with the steps being shown.

4.2.5 Editing for Universal Design (UD).

Universal Design (UD) refers to the concept of designing resources to be usable to the greatest extent possible by everyone (National Disability Authority, 2014). Those with a hearing impairment should be considered during the editing process. If the video does not make sense with the sound turned off it is unlikely to be of benefit to a hearing-impaired user. Videos should be captioned with text, preferably during the editing process to ensure accuracy, although both free and subscription-based automated captioning services are also available. YouTube, for example, has a free automatic captioning service available in the Video Manager section of the site. The service is constantly evolving and improving but some audio may be incorrectly transcribed. Errors can be corrected by selecting the “Subtitles & CC” option on the video, selecting your preferred language and then editing the text. Care should be taken to ensure the

captions are synchronised to the action for optimal clarity. Consider providing transcripts for lengthy audio content, such as narration. YouTube has the capacity to automatically convert the audio from a video into text to facilitate the rapid production of transcripts (Google, 2020).

In keeping with the principles of Universal Design, captions and transcripts may also benefit other users (Padden, O'Connor & Barrett, 2017). Being able to access the text during viewing can improve the comprehension of people with learning difficulties or those for whom the video is not in their first language. Viewers in a noisy environment may not be able to hear the audio, while those watching without headphones or in a quiet public space (such as a library) may wish to avoid disturbing others.

4.2.6 *Final editing steps.*

The final cut of the video should be evaluated to ensure it meets the goals set out at the planning stage and a concise and useful recording has been produced. Once completed, the video should be shown to the course instructors for feedback on the production and content quality before it is exported for sharing and online streaming.

> **Practical tip:** editing can be an extremely time-consuming process so try to allow plenty of time for it. Remain focused on producing a useful and functional clip rather than a cinematic masterpiece!

Video and audio production, as well as editing, are highly specialised and technical fields. This article is intended to provide a brief introduction to some of the key concepts. Academic institutions may offer additional training for staff. There are also many excellent online training sites which offer tips and tutorials on every aspect of film making. Vimeo Video School or the Viewfinder blog on kitsplit.com are just two examples.

5. Exporting the video.

Exporting takes the assembled clips, audio and effects from the timeline and converts them into a single file, ready for viewing.

Video file formats are:

- Containers
- Codecs

- Compressing

A container is a collection of all the information associated with a video file. As well as the actual audio and video, it includes additions such as the title, descriptions, keywords or thumbnail images. For online video .mov and .mp4 are the two most common containers used. They are visible on the file name extension.

'Codec' is short for compression-decompression. This is an algorithm whose job is to compress the finished video file to make it smaller and therefore easier to store, edit and share online. It also decompresses that file when it is downloaded for playback. Two commonly used codecs are H.264/AVC and Apple ProRes (used by Apple products). H.264 is very widely used as it is able to compress SD, HD and UHD video into small files that can be easily uploaded and shared but still have excellent image quality.

The frame rate is the number of frames (images) that the video displays per second (fps). If "current" is available as a programme option, it is generally best to choose this. To keep it straightforward the file can also be exported using the same frame size as it was recorded in e.g. 640x480 for standard definition 4:3 video and 1280x720 or 1920x1080 for full HD. Alternatively, the frame size or resolution can also be adjusted at this point if necessary. The video may also be exported more than once, using different file settings, to facilitate sharing and viewing across a variety of devices or locations.

5.1 Access and Sharing.

Once the final video edit is completed and exported, the mechanism of sharing it with the target audience should be considered. Even after compression for export, the size of most video files makes email sharing impractical, so sites such as YouTube and Vimeo are useful. Both these and other video sharing platforms will further compress the file to facilitate ease of streaming and viewing without reducing the quality of the footage. One important aspect at this stage is privacy. Video sharing sites typically carry a range of options; [1] Public/Anyone – the video is free for anyone to view and can be found with a simple online search, [2] Unlisted/Only people I choose – the video is on the creator's channel but not publicly available. People can only view the video if they are provided with the direct link (bear in mind however that viewers may be able to pass the link on to others if they wish) and [3], Private/Only me; the video is only available to view by direct invitation. Some sites also allow groups to be created where selected videos are shared with the group members. This option may be useful for educators as an entire class

can be granted access. Piloting the video with a small number of users initially and asking them for feedback on ease of access is recommended. This allows any delays or errors in the process to be identified and corrected before the work is shared with the entire target audience.

When uploading the video, the creator can enable or disable the commenting feature, allow or prevent video sharing or embedding on other sites and add keywords to enable online users to locate the work. Consider turning off the setting enabling the suggestion of similar content to autoplay after the video on some streaming sites. This helps avoid the users assuming that subsequently displayed contradictory or unsuitable material is also relevant. Virtual learning environments (VLEs) can also be used to distribute videos to a specific class/group. Another option is to create and use QR barcodes to share the video (Bright *et al.*, 2015). These services generate an image code that is linked directly to the online video. This can add an extra dimension to any handout/manual, as students will be able to scan the code with their smartphone camera or a dedicated app and view the video of interest at the relevant point, rather than having to trawl through emails, hyperlinks or VLE pages to find the correct video (Bree, 2017a).

It is worth taking the time to carefully review the sharing and privacy options for whichever distribution platform is chosen. Institutional IT departments may also have relevant policies and can be a useful source of advice and guidance. In certain cases, password protecting videos should be considered, such as in the case of sensitive footage e.g. surgical procedures. It may be best to assume anyone could potentially end up viewing it, so add warnings about graphic visuals for example, if appropriate.

5.2 Video Metrics.

VLEs, video streaming and web hosting services may aggregate data that is useful in evaluating the effectiveness of videos (English, 2016).

Individual streaming or sharing sites may use slightly different terminology to describe these values but some key metrics for educators to be aware of include:

- View count
- Play rate
- Engagement
- Social sharing

- Feedback

Sample metrics from a training video are illustrated in Table 2.

Table 2 Sample video metrics for a training video for the 2018 calendar year

Video title	Manual handling
URL	https://vimeo.com/136952244
Duration	02:14
View count	13409
Play rate	5329
Finishes	2232
Engagement	69%
Downloads	12

5.2.1. View count.

The view count refers to how many times the webpage containing the video has been viewed. It indicates the reach of the content. However, this value can be deceptive, as there are variations in how the views are counted across platforms. For example, a video must be viewed for 30 seconds on YouTube before a view is logged, versus only three seconds on Facebook.

5.2.2 *Play rate.*

The play rate is the percentage of page visitors who clicked play and actually began watching the video. It indicates how relevant the video is to its location and its success in engaging visitors. Bear in mind that specialised video content is likely to have a lower play rate than one on a broader topic.

5.2.3 Engagement.

The engagement value indicates how much of the video each viewer watched, expressed as a percentage. Average engagement is the mean viewing time across all viewers. This is very useful information as it helps to gauge the usefulness of the video(s) to viewers.

5.2.4 Social sharing.

Social sharing metrics only apply if videos are available for users to share or like on social media feeds. They are a broad indicator of how appealing a video is to its audience.

5.2.5 Feedback.

Video feedback is qualitative data gleaned from viewers' reactions, comments or queries. It is helpful to keep track of both digital and in-person comments received, which may require the aggregation of feedback from student evaluations, VLE forums or the comments section on the video sharing site (if enabled). This evidence can be helpful in tailoring future content to improve its relevance.

6. Conclusions.

In summary, the production of customised videos can allow educators to successfully engage with their students, assist student understanding of particular topics and help to prepare learners for practical sessions and skills acquisition. However, inaccurate or poorly designed videos can cause confusion or disengagement. Academic staff often mention lack of time and training as two barriers to the utilisation of video technology in their teaching. This article presents some practical recommendations to assist those who wish to begin making videos, as well as those who have already begun to generate in-house video content and are keen to improve further. It is hoped that this guidance will help to improve the efficiency of the process and reduce the demands on educators' time.

Investment in equipment and training, along with encouragement to collaborate with colleagues who are experienced in video creation and utilisation, could build educator confidence and increase the integration of these flexible learning supports into effective and student-centred teaching. The authors would like to encourage educators to develop a teaching video library, pilot and evaluate it with learners and then scale up its use over time if it is found to be an effective and time-efficient teaching intervention.

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8. Appendix: Glossary of terms used in this article.

4k: Refers to ultra-high definition footage.

Action camera: Small, rugged camera with waterproof housing and a variety of mounts, also called point-of-view camera.

App: A computer application, particularly one downloaded to a mobile device.

Aspect ratio: The proportional relationship between screen width and height expressed as a ratio, also called screen ratio.

Bluetooth: A standard for short-range wireless connections between electronic devices.

Boom microphone: Microphone mounted on a pole or camera.

B roll: Supplemental or alternative footage, also called “cutaway”.

Camcorder: A device that records both audio and video.

Closed captions: Subtitles plus a written description of what is happening on screen for viewers who may not hear or understand the audio.

Codec : An algorithm that compresses the finished video file for export and playback.

Colour correction: Refers to changing/improving the colours in an image or footage during editing, also called grading.

Compact camera: A small camera lacking a removable lens, also called a point-and-shoot camera.

Compressing: The process of compressing data to result in smaller file sizes for easier and faster transmission and storage. Also known as file zipping. Compression can be ‘lossy’ or ‘lossless’ (meaning either some or no information is lost during the process).

Container: All the information associated with a video file.

Copyright: A legal right that grants the creator or owner of a work control over how other people may use it.

Creative Commons: A group of public copyright licences that enable the free distribution of an otherwise copyrighted work.

Cropping: The removal of some outer areas of an image or footage sequence. Digital footage may be cropped to change it from one aspect ratio to another without stretching or distortion.

Crop sensor: Any digital camera sensor that is smaller than a full frame sensor or a 35mm film frame.

Cutaway: Another term for B roll footage.

Digital camera: A camera that records images or video footage onto an electronic light sensor (instead of photographic film).

Digital zoom: A close up effect achieved by cropping and enlarging the image during editing, with a resultant loss of quality.

Embedding: The integration of video or other digital content into webpages or social media posts.

Engagement: A metric indicating the proportion of a video watched by viewers.

Face detection: Software that enable a camera to remain focused on subjects' faces, even while moving around in the frame.

First person POV: A camera mounted on operator's head or body to obtain footage from their perspective.

Frame : The scene as visualised when looking through the camera or a single image constituent of film footage (a measure of time).

Frame rate: The number of still images (frames) per second of footage.

Frame size: The screen dimensions, measures in pixels.

Full frame camera: A digital camera whose sensor is the same size as a single frame of traditional 35mm film (36 x 24mm).

Full HD: Screen resolution of 1920 x 1080px.

Gimbal: A pivoted support that allows the camera to rotate around a single axis.

GPU: The graphics processing unit is a computer chip (processor) specialized for display functions. The GPU renders images, animations and video for the computer's screen.

H.264: A widely used video compression standard.

High definition: Screen resolution of 1280 x 720px.

Handheld camera: Shooting while holding a camera, may result in jerky/shaky footage.

Image stabilization: Camera software setting that (somewhat) smooths out movement when shooting handheld.

Interchangeable lens: A lens that can be detached from the camera body. This allows the use of a variety of lens and shooting techniques.

Keywords: Terms or phrases used to tag clips or videos to facilitate searches.

Kit lens: A "starter" lens sold with an interchangeable-lens camera, typically a relatively inexpensive lens.

Lavalier microphone: A small microphone which is attached to clothing.

Lens: A transparent piece of glass or plastic with at least one curved surface. A digital camera lens gathers and focuses light onto the camera sensor to capture an image.
Levels: The loudness of the audio of a clip, measured in decibels (dB) from infinity dB to 0dB.
Light sensor: The part of a digital camera that captures the image.
Liquid crystal display: An electronic display whereby a varying electric voltage is applied to a liquid crystal layer of pixels to create an image.
Mark in: Placing a marker at the desired beginning of a clip during editing.
Mark out: Placing a marker at the desired end of a clip during editing.
Memory card: A device that stores the images, audio and footage recorded on a camera.
MiniSD and microSD: Smaller memory cards for smart devices.
Mirrorless camera: A digital interchangeable lens camera without the reflex mirror found in DSLRs. This results in a less bulky camera.
Non-destructive editing: Using software to edit imported footage without altering the original files.
Non-linear editing: Editing footage using software that does not alter the original footage.
Optical zoom : A “true” zoom that allows you to zoom in or out on the subject in the camera viewfinder without moving the camera.
Pan: Moving a camera horizontally.
Peaking: An audio level >0dB, causing it to distort.
Pixel: Basic programmable unit or point on a computer display, its colours are created by blending red, blue and green light.
Plate: A fitting that securely attaches a camera to a tripod or other mount.
Play rate: The percentage of page visitors who began watching a video.
Point-of-view (POV): The location of the camera in a shot to indicate what the subject is looking at.
Post-production: The editing of footage from the end of recording to production of the finished version.
Pre-production: The initial planning of a film shoot, up to the start of filming.
QR code: A two-dimensional machine-readable optical barcode that contains information about the item it is attached to. It consists of black squares arranged within a square grid on a white background and can be read by a camera.
RAM: The random access memory temporarily stores data, serving as the computer's ‘working’ memory.

Rough cut:The initial arrangement of clips in the desired sequence during editing.
Screen resolution: The measure of the number of pixels a screen can display, measured as width by height. Higher resolutions result in sharper images.
Shooting: The act of recording images or footage on a camera.
Slow motion: A film effect where time appears to be slowed down. It can be achieved by capturing the footage using a higher frame rate than it is played back in.
Smart device : An electronic device that can connect to a network and interact with the user and other devices.
Social sharing: The number of likes and/or shares a video receives on social media platforms.
Standard definition: Screen resolution of 640 x 480px.
Steadycam: A stabilising camera mount that isolates it from shocks or vibrations.
Stylus : A pen-shaped item that is used to input information or commands on a digital touchscreen.
Subtitles: Viewer instructions or the video's dialogue appears on screen as text.
Tablet : A small, touchscreen computer with a mobile operating system.
Tilt: Moving a camera vertically.
Time lapse: This technique consists of recording a sequence of frames at set intervals over a relatively long period of time. When the frames are played back at normal speed the action appears to be speeded up.
Timeline: The section of the editing software where clips are placed during editing.
Titles: On-screen text, subtitles and captions.
Tracking: Camera following a moving subject to keep them in frame.
Transition: A visual effect as the video moves from one clip to the next.
Trimming: Removing some of the start and/or end of a video clip during non-destructive editing.
Tripod : Three-legged frame used to stabilise and/or elevate a camera.
Ultra-high definition: Screen resolution of 3840 x 2160px or above, often shorted to "4k".
Universal Design (UD) The concept of designing resources to be usable to the greatest extent possible by all people.
Universal Design for Learning (UDL): Universal Design for Learning (UDL) is a set of principles for curriculum development that give all individuals equal opportunities to learn.
Video RAM (VRAM): A type of random access memory (RAM) used to store image data for a

computer display.

Video sharing website: An online video platform that allows users to upload, convert, store and playback videos e.g. YouTube, Vimeo.

Video streaming: Media viewing during which the video data is continuously delivered to the viewer's device via an internet connection without being downloaded.

View count: How many times a video has been viewed online.

Viewfinder: The part of the camera the operator looks through to view and compose the shot. They may be optical or electronic (some cameras have both).

Widescreen: Footage with a frame size ratio of 16:9.