OPTIMIZING VIDEO FOR LEARNING

A case study-based primer of informal, educational, digital video best practices

Elizabeth Choe¹

¹Massachusetts Institute of Technology, Cambridge, MA, USA

Correspondence: echoe@mit.edu

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INTRODUCTION

The expertise and work around educational video is often siloed. This paper attempts to connect those dots through case studies of existing videos.

Digital video has exploded as an educational tool in the last decade, with Massive Open Online Courses (MOOCs) launching in the mid-2000s and platforms like YouTube, Facebook, Google Hangouts, Periscope, and Meerkat that increasingly lower the barrier to video production and distribution. Since its launch in 2005, YouTube has become one of the most popular sites of all time (Welbourne and Grant 2015), with over half of its adult users reporting that they use it to watch educational videos (Purcell 2013). The 2009 launch of YouTube EDU, a curation service for educational YouTube videos, shows just how much educational content exists on the site. And while YouTube dominates the informal, educational video space, people view, share, and discuss videos on other curation platforms like: watchknowlearn.org, teachertube.org, edutopia.org/videos, neok12.com, edutube.org, and curiosity.com. Television networks re-package their content into educational online videos through sites like discoveryeducation.com, PBSlearningmedia.org, and NBCLearn.com. Even non-profit institutions like NASA and the National Science Foundation produce their own original online videos (see nasaeclips.arc.nasa.gov and science360.gov). And this doesn’t even touch all of educational video mobile apps that have emerged in the past several years.

There’s a lot of talk around educational videos, too - Google Scholar returns 437 peer-reviewed journal articles with the words “videos” and “learning” in the title published in 2015 alone. And while digital educational video is relatively young, people have been discussing video as an educational medium since at least 1950, when educational television first emerged (King 2000).

If we’ve been producing and researching educational video for so long, why are there still so many bad educational videos? There are many reasonable explanations, but one that stands out is that navigating the sheer volume of best practices for educational video isn’t exactly straightforward. Not only are the makers, users, and researchers of video very different from each other, but there’s also a huge amount of diversity within the communities of making, using, and studying. Among video producers, there are amateur do-it-yourself-ers, universities, commercial media/news entities, broadcast networks, and corporations, whose expertise and interests can range from the content itself, to marketing and communications, to video production, plus, best practices haven’t been fully defined in the digital age. As YouTuber Hank Green says,

Most people who are trained in video creation are trained with TV and film in mind. There aren’t a lot of “Online Video Studies” programs at Universities… People who are new to the medium are starting to think that online video is not “Just a little bit better than everything else on YouTube” but “Just a little bit worse than everything on TV.” That perspective is a super dangerous road to go down. (Green 2014)

The users and researchers are varied, too. Audiences consume educational video in formal classroom settings, but also informally on their phones, at home, and on social networks. And those 437 papers mentioned earlier were published in journals as diverse as: the Journal of e-Learning and Knowledge Society, the Journal for Nurses in Professional Development, Information and Communication Technology, Computers in Human Behavior, and the Journal of Geography in Higher Education. Plus, additional and arguably more accessible and practical analysis exists outside the traditional academic platforms, on blogs and websites.

Through case studies of existing digital educational videos, this paper attempts to connect, curate, and distill the work conducted in these silos of research, use, and production. It is a review of the landscape of educational video best practices and research as of early-2017, written especially for producers and educators who use video in their teaching practice. This is by no means an exhaustive review and reflects my own personal, subjective opinions on leveraging digital video as an educational and social medium. I invite commentary and thoughts, as well as recommendations for other research I may have missed.
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1. WHY SHOULD I MAKE A VIDEO?

Videos should transform a live experience instead of merely transmitting it. What will your audience get out of a video that they won’t from another medium?

Video is not a silver bullet. There’s actually very little evidence, if any, that suggests that video is inherently a superior medium to text, images, etc. to help people learn (Muller 2008, Mayer 2005). Video, done poorly, is not as good as other tools (Koedinger 2015) and for some cognitive tasks, is actually worse than print (Koumi 2015). In some cases, static pictures promote learning more effectively than videos or animations, presumably because viewers have to use some imagination to fill in some details, providing just enough cognitive load to make the material more memorable (Muller 2008, 2014). And of all the ways to share content, videos and digital games are the most expensive to produce. Good videos work for learning because they are good videos, not simply because they are videos. Like any other medium, it’s the deliberate instructional approach manifesting in the medium that facilitates learning, not the physical video itself (Koumi 2015, Muller 2008, Mayer 2009, Mayer 2014). There’s no one-size-fits-all technical approach to video - no style, format, length, or talking speed that is universally “The Best” (despite what’s suggested in Guo et al. 2014). It’s more important to make conscious choices of technical elements based on your overall learning objectives and how you want people to use your video (Hansch et al. 2015, Karppinen 2005). Remember, “The road to bad video is paved with no intent” (Stockman 2011).

Why should you make a video? At its best, a good video can:

a) transcend space and time to make concepts clearer or more interesting
b) spark curiosity and emotions that promote learning or sharing
c) encourage participatory and/or social learning and build identity
d) facilitate an educational, creative process (when you produce one)

Other media and teaching methods can certainly achieve these things, too - it’s just that a well-executed video may simply do it more easily or at a larger scale in certain circumstances.

a) Videos can transcend space and time to make concepts clearer or more interesting:

Showcase a person of interest (a renowned physics expert, an engaging personality, etc.) who is otherwise only accessible to a few people and who can speak about content that’s unique to them (their research, their perspective, their expertise, their life experience).

Showcase demonstrations, experiments, and hands-on procedures. Use videos to help teachers learn processes like classroom management, use them as tools for self-reflection, and use them to show off demonstrations that are difficult to analyze in real-time.

Showcase places or events not easily accessible and contextualize and/or visualize concepts. Open windows into worlds of laboratories, phenomena, and facilities that are usually too small, too large, too fast, too slow, too remote, or too rare for the average viewer to experience.
How to showcase a person of interest:

This is one of the oldest uses of educational video - a study back in 1969 recommended using video to scale up limited instructional resources (i.e. an expert teacher) to a wider audience, and also to blend video segments with in-class discussions (Welliver 1969). It’s also one of the most common uses of video, providing the foundation of everything from TED talks, Big Think, and Bravo’s Inside the Actor’s Studio, to The Great Courses and MOOCs.

Why it can work: While it’s not a revolutionary use of video, showcasing a person of interest can be effective when leveraged properly. Richard Mayer, a professor of psychology at the University of California, Santa Barbara who researches multimedia learning theory, promotes video usage that “personalise[s] a learning situation, to make an author more visible so the learner feels ‘like there’s an actual person who has these famous ideas’” (O’Donoghue 2013). Mayer suggests that this personalization fosters generative processing - having a “human element" helps motivate audiences to make sense of the presented material (Mayer et al. 2004). Hansch et al. similarly point out videos’ capacity to build rapport and establish an emotional connection with viewers and motivate them by conveying enthusiasm (Hansch et al. 2015).

Pulling it off: The key to maximizing the person-of-interest potential of video is having talent/a host (and an overall aesthetic) who is authentic, natural, conversational, who maintains a speaking style and enthusiasm that is true to their personality and has unique perspectives, expertise, and/or abilities that make them irreplaceable talent. The execution is critical (Mayer 2014, Moreno et al. 2001). Mayer recommends 12 principles of multimedia design based on experimental research and cognitive theory that suggest that people learn better from multimedia that’s designed consistently with how the human mind works. Three of those principles apply directly to the human presence in videos:

a) Personalization: For scripts, first person, active voice, and contractions are much better than formal, academic styles of writing. Write how you talk.

b) Voice: “Natural” styles of speaking are better than robotic, machine-like, or foreign-accented voices. Talk to your audience, don’t read to them.

c) Embodiment: If you’re on-screen, “human-like” gestures like slight movement of the arms/hands, eye contact, blinking, and normal facial expressions are better. Don’t be a frozen presenter. (Mayer 2009)

CASE STUDIES: Person of Interest

SAS - STEM Video Contest (Change The Equation) https://youtu.be/CPzZODXSiyU
Format: Montage of interviews spoken directly to the camera.
Context: This was a co-winner of Change the Equation’s 2010 S.T.E.M. is Cool Video Contest, which invited science, technology, engineering, and math (STEM) companies to produce videos to get kids interested in STEM careers. It was produced by an analytics software company and showcases its diverse employees.

Room to Improve: Individuals’ short quips are extremely generic, forced, and awkward, and the dated aesthetics (music and visuals) give the impression that this company is trying too hard to be relevant. The sound bites lack authenticity, and because they’re so broad, they don’t show anything particularly unique or meaningful about the speakers. Snappy interview montages are better suited for pieces designed to pique initial interest, but have to be executed with a matching snappy style and people who can be good on-screen (see Exxon Mobil’s “To Do List” commercial as an example: https://youtu.be/iqQq984RY_k). This video is a cautionary tale for videos with on-screen talent and emphasizes the importance of executing the personalization of video well, particularly during casting.

Paul Bloom: The Psychology of Everything (Big Think) https://youtu.be/328wX2x_s5g
Format: Scripted series with an expert host speaking directly to the audience.
Context: Various experts give hour-long crash-courses on their fields of study in this series produced by YouTube channel Big Think. Paul Bloom is a widely-known and published professor of psychology and cognitive science at Yale.
Good: Paul Bloom has expertise and can clearly explain his research. His speaking style, tone of voice, and body language are natural and unforced. It sounds like he’s talking to his students off-the-cuff, not like he’s memorized a script, which is why the video works. It’s not because of the format - which is basically just a lecture - or the slickness of the visuals. Douglas Melton’s episode, “Is Biomedical Research Really Close to Curing Anything?” has the same format, but is much weaker because it feels much more like a rigid, typical “lecture.” He says things like “I’m going to talk about XYZ” instead of just jumping in and talking about XYZ and his body language and speaking style is very rigid. Carl Sagan’s Cosmos, which feels wildly different, also essentially uses the same lecture-style format. Bottom line? Your host makes a big difference.

Room to Improve: The sound effects are unnecessarily distracting (as evidenced by the comments).

Beetles, Mites, Cockroaches, Oh My! (The Brain Scoop) https://youtu.be/rgUP3x8_smY
Format: A host interacts with and interviews guests in an informal, hands-on style.
Context: Emily Graslie hosts this series from The Field Museum in Chicago, featuring the exhibits and scientists of the museum.
Good: Instead of relying on an expert to carry the on-screen presence, this video uses a good on-screen host to facilitate the interaction with the audience. Emily, a popular YouTuber, acts as like the audience representative when she interviews Crystal Maier, who manages the insect collection at the museum. This is can be a strategic approach when the person of interest/interviewee may not have the time or talent to effectively and naturally be the primary speaker on camera. It still requires the primary host to be engaging, memorable, authentic, and natural, though. This video works because Crystal is a natural and engaging presenter, but Emily is especially natural and engaging as the flagship host. Mike Rowe of Dirty Jobs on Discovery Channel is another good example. NASA 360 and the National Science Foundation’s Science 360 are much weaker.

A Video Game that Teaches You How to Code (Fig. 1 by University of California) https://youtu.be/OxYW0bqtiTo
Format: Blend of traditional interview footage with animations.
Context: Fig. 1 is a weekly YouTube webseries produced by the University of California, where interviews with researchers are blended with animations.
Good: Blending interview footage with well-produced animations is another way to avoid relying too heavily on a talent’s on-screen presence.

Room to Improve: This series has more of a news rather than educational bent, so while it is clear, concise, and has a beautiful aesthetic, restructuring its script to more align with Jack Koumi’s suggested framework (p. 38) might better facilitate learning.

Format: Combination of interview audio and other visuals.
Context: This particular video uses audio from a lecture given at NASA and overlays NASA archival footage and visualizations.
Good: The video generally maintains good audio-visual complementarity - what you see on-screen usually enhances or matches what’s being said in the lecture audio. It remixes NASA’s unique media assets and the expertise of this speaker and tries to win where it can.

Room to Improve: The music is over-the-top and corny and creates a artificial Hollywood blockbuster tone that does not match the less energetic, dry tone of the narration and visuals, which is very distracting and unintentionally funny. The video also feels like a bombardment of trivia facts without a coherent story - it’s unclear whether that’s because of the actual talk itself or the editing of the video, which has just cut and pasted together sound bites from the talk without any connective tissue. Delineating unrelated segments with different “chapter” markers can help viewers more easily process this information - Mayer calls this the Segmenting Principle (Mayer 2014). For example, this video could be re-edited as “5 ways the Viking spacecraft changed science” with image cards saying things like “#1: We figured out how to land things on Mars.” While the listicle format can easily be gimmicky, it also has its place in making information easier to understand.
How to showcase demonstrations, experiments, and hands-on procedures:

Why it can work: Educational video has been widely used and studied in skills and procedure training, particularly in nursing education (Forbes et al. 2016) and teacher training (Seidel et al. 2011, Brunvand 2010, Chittleborough 2015, Derry 2007, Santagata et al. 2007). Videos provide a low-stakes world to learn processes like classroom management, making them useful tools for self-reflections (Chittleborough 2015). They’re even considered to be just as, if not more, effective for classroom observations (Best Foot Forward 2015). Videos can also show demos that are hard to replicate live, and because you can manipulate space and time in them, videos can help facilitate experiential learning and mimic cognitive apprenticeship to build skills (Koumi 2015).

Pulling it off: As with showcasing a person of interest, everything lies in the execution. Leverage aesthetics (look, sound, framing, lighting, etc.) to make demos as clear as possible, and employ “creative practitioners and allow them adequate resources and thinking-time to exploit the full-potential of each medium’s presentational capabilities” (Koumi 2015).

CASE STUDIES: Demos, Experiments, Procedures

Coriolis Effect (National Geographic) https://youtu.be/mPsLanVS1Q8
Context: This is a clip from All of the Above, a TV show broadcast on the National Geographic Channel. It explains the Coriolis Effect, an unexpected phenomenon of moving objects explained by physical reference frames.

Good: The Coriolis Effect is difficult to understand unless you see it in action, and this video does an effective job of using various camera angles and animation overlays to show it. It allows people to view the phenomenon much more clearly than they would in a live demonstration (and the live demo is a little tricky to do in typical classrooms, anyway). It works as a standalone video but could also be used during a lesson on the laws of motion.

Note: The acting and hosting are cheesy, but at least they reinforce the strangeness of the Coriolis effect.

Context: This video was produced by MIT’s Technical Services Group, who perform large-scale demonstrations for MIT’s freshman physics courses. This extremely bare-bones production is meant to be a training resource for instructors of the physics course or for use in blended learning environments.

Good: The animation tracks overlaying the path of the ball, along with more slow-motion replays (compared to National Geographic’s version), are helpful.

Room to Improve: I find the effect more clearly demonstrated with the 4-person contraption in NatGeo’s video, in addition to NatGeo’s clearer picture and audio quality and animation. This video was posted on YouTube two years prior to the NatGeo one. I would hesitate re-making a Coriolis Effect video unless it was able to contribute something different or more enhanced than the NatGeo one.

How to Wind a Bobbin (Howcast) https://youtu.be/XMPx9aF5eg4
Context: Howcast is an extensive YouTube channel with short, how-to videos and tutorials on things like like sewing, dancing, cooking, and software use.

Good: This is a fairly decent example of using video to enhance instructional capabilities. Users can replay parts of the video for clarity. The host’s conversational tone allows her to naturally interject tips and tricks. The simple background and setup allow viewers to focus on the technique being shown.

Room to Improve: This format would have benefitted from using splitscreens to show multiple angles and close ups of the bobbin in the context of the sewing machine. Shooting from multiple camera angles would have also avoided shots where the talents’ arm blocks the sewing machine parts.
Mythbusters Diet Coke and Mentos (Discovery) [https://youtu.be/LjbJE1LligZg](https://youtu.be/LjbJE1LligZg)

**Context:** The hosts of the popular engineering TV show, Mythbusters, re-create the viral video of Mentos and Diet Coke to understand the geyser-like explosion.

**Good:** Most people can actually do this experiment fairly easily, so the experiment itself doesn't make for that interesting of a video. What makes this video worth watching are the hosts, who work through their scientific hypotheses in a natural, conversational tone, and integration of slow-motion footage and animations that make the explanation clearer than what is visible in the live experience.

**Caveat:** The loud, bold tone reflects the Mythbusters brand and these particular hosts, but not everyone can pull it off.

A Baffling Balloon Behavior (Smarter Every Day) [https://youtu.be/y8mzDvpKzfY](https://youtu.be/y8mzDvpKzfY)

**Context:** Destin Sandlin’s extremely popular YouTube channel, Smarter Every Day, unpacks the physics and science behind various phenomena.

**Good:** Smarter Every Day’s seemingly low-key production (seemingly) - Destin spends over 100 hours, on average, to produce his ~10 minute-long videos (Destin) - works because Destin is arguably one of the most natural, effective, and effortless science presenters. This episode illustrates an demo that is otherwise hard to show to large groups of people and makes use of effective visual metaphors (the water-filled jar) to explain the fluid dynamics of air. The personal production style matches Destin’s casual presentation style and he uses just enough visuals to complement his narration.


**Context:** This is an article published by JOVE, the Journal of Visualized Experiments, a peer-reviewed scientific video research journal. Researchers use video, in addition to text and figures, to describe their experiments, particularly ones involving new methods.

**Good:** This video shows a new tissue engineering technique in rats and is much more clearly communicated through video than through words and pictures.

**Room to Improve:** While the demonstration is useful, it could have benefited from overlays labelling various parts of the rat. For all JOVE articles, researchers read aloud an extremely formal, passive script similar to a written journal article. It’s very unnatural and unnecessary, and makes it difficult to understand them. And according to Mayer, these unnecessarily formal and unnatural scripts actually hinder learning, whereas first-person, active language is better (Mayer 2009).

Parchment Baked Salmon 4 Ways (Tasty) [https://youtu.be/l96aJe_OQVc](https://youtu.be/l96aJe_OQVc)

**Context:** Tasty is Buzzfeed’s cooking YouTube channel consisting of short, simple video recipes shot from a birds eye point of view. The videos use text overlays instead of audio narration so viewers can watch with or without sound (presumably since most viewers watch them on their Facebook feeds).

**Good:** This minimalistic video uses big, clear text and framing to highlight the ingredients and food as it cooks. Cooking is a type of competency that benefits from video instruction - hospitality students were able to better retain and engage with video recipes compared to print and images (Wang et al. 2016). It’s the quirky, include-only-what-you-need production style of these videos that makes the recipes seem doable, which also accounts for their massive virality (McKelvey 2016). However, this format does not work on a much more complex recipe, such as Bon Appetit’s “How to Make Great Bread at Home” ([https://youtu.be/rJ6WH4x1iZA](https://youtu.be/rJ6WH4x1iZA)) - one size does not fit all, when it comes to video.

**Caveat:** While it’s clear that these videos are widely shared, it’s unclear whether or not they actually help people learn how to cook. By making it seem like delicious results are easy to achieve, some argue that these types of “food-porn” videos serve as inspiration/starting points for novice cooks (McKelvey 2016) who want to learn a specific recipe, but do not effectively teach the cooking process, which involves making mistakes, tweaking, swapping ingredients, and adapting on-the-fly etc. (Hein 2016). Essentially, by oversimplifying the process, it’s a misleading representation of cooking. Clifford et al. also found that while a cooking show may help viewers gain knowledge about nutrition, it doesn’t necessarily lead to changed eating or cooking habits (Clifford et al. 2016).
How to showcase places/events not easily accessible and contextualize or visualize concepts:

A few examples include: demonstrations discussed above, classroom observations for teacher training, historical footage, particular research labs, places around the world, case studies/masterclass-like footage, intimate Q&A/ interviews with a person of interest, and showing a physics concept in action.

Why it can work: Videos can provide visual metaphors that make abstract concepts tangible and more engaging (Miller 2009), promote understanding and recall (Eppler 2006), give meaning to inaccessible places (Bonk 2008, Eick and King Jr. 2012), and visualize the invisible through “amplified realism” (Koumi 2015). This “amplified realism” can take the form of animations of molecular biology processes (Thornton and Wiltrout 2015), extreme close-up and/or slow-motion footage of a string vibrating, time-lapses of a coral reef from satellite view, showing processes out of temporal sequence, showing phenomena side by side, etc. Video can place concepts in their relevant contexts, and learning sciences research suggests that experiences that allow learners to contextualize materials in their own mental models or frameworks of thinking better facilitate learning (Gagne et al. 2004, Halpern and Hakel 2003).

Pulling it off: Use the plastic elements of video - slow motion, animations, etc. - deliberately to advance understanding of a concept, not as a gimmick. For instance, don’t use animation just for animation’s sake. Of Mayer’s 12 multimedia principles, here are seven related to using technical elements of video to make concepts clearer:

a) Coherence: Try to avoid adding material.
b) Signaling: Add visual or musical cues to highlight ideas.
c) Redundancy: Animation with narration is better than animation, narration, and on-screen text.
d) Spatial Contiguity: Keep text and related graphics close to each other on-screen, not far apart.
e) Temporal Contiguity: Have related graphics and narration happen at the same time, not successively.
f) Modality: Graphics and narration work better than graphics and text.
g) Image: Having someone explain something on-screen isn’t inherently better than having a narrated animation - if you’re showing someone, make sure there’s a reason why. (Mayer 2009)

CASE STUDIES: Windows into Inaccessible Worlds

**Digizyme’s WGBH Animation** [http://www.digizyme.com/wgbh.html]

**Context:** This particular animation, developed for WGBH, explains molecular bioengineering techniques.

**Good:** These visualizations are beautiful and clean and allow viewers to “see” microscopic processes like cutting DNA.

**Room to Improve:** The extremely unnatural and rigid narration sometimes refers to something totally different from what is conveyed on screen, which is confusing.

**The microbial jungles all over the place (and you) (TED-Ed)** [https://youtu.be/pHLP5CZMnL4]

**Context:** TED-Ed is a popular YouTube channel with short (less than 5-minute) videos written and/or narrated by expert educators and are entirely animated in a cartoon style. This episode explains how bacterial communities form biofilms.

**Good:** The visuals help explain a microscopic process that involves multiple players interacting in a complex ecosystem. This video shows and hides different parts of the biofilm to coincide with explanations, an affordance unique to videos and gifs.

**Caveat:** The narration and script is occasionally overly formal, but they do complement the visuals. And while the video works, biofilms can also be explained through infographics like [http://femsre.oxfordjournals.org/content/36/5/972].
Secret of Snapping Spaghetti in SLOW MOTION (Smarter Every Day)  
https://youtu.be/ADD7OIOoFFI

Context: Destin Sandlin’s extremely popular YouTube channel, Smarter Every Day, unpacks the physics and science behind various phenomena.

Good: A high-speed camera allows Destin to show and explain the mechanics of why spaghetti snaps into three pieces instead of two.

Room to Improve: I had to rewatch the explanation (starting at 4:47) multiple times to understand his analysis, which could have been clearer with a different approach to the animation overlay. But because it was a video, I could replay the explanation as many times I as needed.

The Structure of DNA (MITx Bio)  
https://youtu.be/o_-6JXLYS-k

Context: This animation of the structure of DNA was created for MITx 7.28.1x Molecular Biology: DNA Replication & Repair, a massive open online course offered on edX. The style is more informal than Digizyme’s, but not as cartoony as TED-Ed’s.

Good: Like with the biofilm video, a non-video format - like a blog post using stills from this video and some corresponding text - might have worked just as well. The benefit that this animation offers is showing the winding and unwinding of the DNA structure, morphing structures to show how chemical entities can be represented in multiple ways, and fading out/highlighting certain structures to correspond with the narration.

Room to Improve: While this is a very clean, straightforward video that works well in blended learning settings, the narration might work better with a more conversational tone (for example, speaking with contractions) to better achieve the Mayer’s personalization (Mayer 2009), and the script could be framed around common student misconceptions of DNA (Muller 2008). This restructuring might also attract viewers who don’t already have inherent motivation to learn about DNA.

Gravitational Waves Explained (Piled Higher and Deeper (PhD Comics))  
https://youtu.be/4GbWfNHtHRg

Context: PhD is a popular webcomic about life in academia and the corresponding YouTube channel features animations in the style of the webcomic. This one came out shortly after the high-profile news that LIGO facilities detected gravitational waves.

Good: This was one of the few things that actually helped me understand gravitational waves, largely thanks to the conversational and authentic delivery that complemented clear visual metaphors. News videos and press releases focused on the significance of the discovery, but were unhelpful in explaining the science.

Caveat: As a viewer, I was already motivated and interested in learning about this topic - this video spends very little effort to engage audiences who may not already interested in LIGO.

How Braces Work (MITK12Videos)  
https://youtu.be/6zzA4BU2e58

Context: Science Out Loud is a web series hosted by MIT undergrad and grad students. This episode covers the concepts of bone remodeling, drug delivery, and anatomy in the context of braces.

Good: Constructivist learning occurs when learners integrate new ideas into existing knowledge and personal experiences, making meaning instead of just consuming knowledge (Ackermann 2001). This video not only allows viewers to “see” the microscopic processes associated with bone remodeling through animation overlays, but also helps viewers make sense of complex science concepts in the context of their lived experiences (i.e., having braces). It’s also our most-watched video and the one with the most diverse audience.

Room to Improve: We could have more thoughtfully integrated visual cues and interactions with the audience. While the hosting style isn’t entirely rigid, the script and performance could have been more natural.
Slicing Three-Dimensional Figures (Math Shorts)  [https://vimeo.com/82400980](https://vimeo.com/82400980)

**Context:** This short video is part of the PBS Learning Media series, Math Shorts.

**Good:** This is a simple, clear use of video to visualize concepts that are otherwise difficult to intuit - the different two-dimensional shapes that result from slicing cylinders and pyramids. The high degree of audio/visual complementarity results in an extremely concise explanation of this one particular topic.

STEM Career, Petroleum Engineering  [woubpbs](https://youtu.be/4_QT7NQokTk)

**Context:** This is part of the My (Future) Life Career video project, produced by WOUB Public Media, which showcases STEM careers and what high schoolers need to do in order to prepare themselves for these careers.

**Room to Improve:** This is a devastatingly uninspiring video that violates the golden rule of writing: show, don’t tell. It focuses on one petroleum engineer, interviewed in front of a mural, who spends the majority of the video talking very broadly about what petroleum engineers do, and misses out on the opportunity to actually just show what a day in the life of one looks like. There’s an extremely and limited and arbitrary use of b-roll, showing random clips of oil rigs and people looking at maps that often don’t relate at all to the narration. This does not need to be and really should not have been a video - it would have worked much more effectively as a news article or blog post with better photos.

### b) Videos can spark curiosity and emotions that promote learning or sharing:

- **Spark curiosity** by making the familiar unfamiliar and challenging misconceptions - take something viewers might think they know (like braces) and make them see them in a whole new light.

- **Be authentic.** Videos can emotionally connect with and inspire viewers and spur excitement for topics (Koumi 2006, Miller 2009). Write and speak naturally to convey an authentic passion for your content.

- **Use aesthetics to make content easier to understand and to establish tone.** Use color palettes, music, lighting, sound effects, fonts, and an editing style to create a consistent style to evoke an emotion that’s right for your video.

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**Spark curiosity by making the familiar unfamiliar and challenging misconceptions:**

**Why it can work:** Connecting inspiration to the pursuit of opportunities is a real challenge, but it’s still worth trying to use video to spark curiosity, since learning sciences work has shown that when students are curious, their brains are better prepared to learn (Gruber et al., 2014). Muller also suggests that including non-essential information that engages the viewers and promotes interest in a topic can be useful in multimedia to facilitate learning, even if it violates Mayer’s coherence principle (Muller et al., 2008). Industrial engineers have studied impacts of elements like surprise and delight in motivating consumer behaviors (Vanhamme 2000, Vanhamme and Snelders 2003, Alden et al. 2013), and exploratory reviews suggest that curiosity, amazement, interest, astonishment, and uncertainty are important for content to go viral (Libert and Tynski 2015). While these elements can be conveyed through genuine and natural delivery and hosting, they can also be built into the video writing and structure.
Pulling it off: Integrating curiosity-sparking elements into video design can best be guided by the phrase my former teacher, Chris Boebel, often uses:

Make the familiar unfamiliar or make the unfamiliar familiar.

In other words, instead of simply opening with a “hook,” which often ends up being just a gag or flashy opening, frame your approach around making audiences rethink the world around them to cultivate curiosity in a sustained and meaningful way.

Derek Muller found that students in introductory, undergraduate physics courses learned better from videos that directly addressed common misconceptions about physics concepts than ones that simply prescribed formulas and terminology or even ones that used real-world examples (Muller et al. 2007). In making the familiar unfamiliar, you can confront viewers’ bias or initial perceptions of topics. This is the foundation of Piaget’s theory of constructivist learning, which says that we learn when our understanding of how the world works is violated or challenged, and we have to find a way to accommodate those violations into our model of the way the world works (Piaget 1973).

Caveats: Metaphors are a useful tool to help show that something familiar is actually very foreign and filmmaking techniques like using a GoPro, high speed cameras, etc., can help viewers see something familiar through literally a new lens. Make sure that you use these filmmaking techniques in a way that actually makes sense and clarifies the content and not as a gimmick. Also, there definitely needs to be additional work to ensure that an initial spark of curiosity best orients a learner to follow a path of connected learning of “academic achievement, career success, or civic engagement” (Ito et al. 2013). Right now, the young people capitalizing the most on online learning are already highly motivated or receive technological and educational support at home (Ito et al. 2013, Hansen and Reich 2015). Think about how you might leverage digital videos to serve other audiences as well.

CASE STUDIES: Spark Curiosity

CRISPR Cas9 And The Mind-Blowing Future of Medicine (Answers With Joe) https://youtu.be/GEWJsOheii4

Room to Improve: Joe uses a few metaphors: he compares mapping 3.3 billion genes in the human genome to looking through 3.3 billion Christmas lights “to find the one that causes heartburn” and the precision of the current state of gene editing to playing the game of Operation with barbecue tongs while wearing boxing gloves. Metaphors can be a useful tool to make the unfamiliar familiar - the problem is, neither of these metaphors are particularly helpful and neither are actually correct analogies. They’re also haphazardly thrown in, so I also found them distracting, which got in the way of piquing any curiosity. I thought his use of the handcart metaphor for repair enzymes, used later in the episode, was more successful since it actually clarified a somewhat hard-to-imagine, microscopic process. Also, be careful with humor - though it may help keep certain viewers watching, it also runs the risk of alienating others. I can see how some people might like Joe’s hosting style, but I personally find it grating.

You Are Your Microbes (TED-Ed) https://youtu.be/1X8p0vhsWRE

Good: The video’s opening sentence makes the familiar (our bodies) unfamiliar - “We each view ourselves as a unique and independent individual, but we’re never alone. Millions of microscopic beings inhabit our bodies.”

Room to Improve: The writing could be more informal - it uses scientific journal sentence structures (lots of passive voice) and unnecessary jargon. For example, “As we learn more about how our microbes interact with each other and with our bodies, we will reveal how we can nurture this complex, invisible world that shapes our personal identity, our health, and our well-being” could be reworded as: “The more we learn about how microbes interact with each other and our bodies, the better we can take care of them and ourselves, too.”
Robert Goldman (Northwestern U/MBL) Cytoskeletal Intermediate Filaments (iBiology)
https://youtu.be/USX87zGd45Y

Room to Improve: Video is an opportunity to convey ideas without being restricted to the traditional lecture format, but this video is essentially a very boring lecture. It launches into definitions of terms without setting any motivational context of the concepts, and the presenter’s verbal and body languages are extremely rigid and formal, making it difficult to pay attention to concepts. Additionally, the visuals don’t always clarify the concepts being described, and in many cases, just make it harder to read and process the information. Finally, even though this video may be aimed at students who are already studying or have an interest in biology, it does little to make them rethink their incoming notions of cytoskeletal intermediate filaments or get them more curious about them. He actually talks about some really fascinating elements, but breezes through them as though he’s reading a textbook out loud.


Good: The topic of this video is how braces work and the unfamiliar element is that they work by making your body break and rebuild itself, which is a process that actually naturally happens all the time as a way your body grows.

Science of Laser Hair Removal in SLOW MOTION (Veritasium)
https://youtu.be/S20-1_XqVPM

Good: Derek Muller, of the popular YouTube channel, Veritasium, successfully implements a visual hook - slow-motion footage of his arm hair getting lasered off. It conveys a phenomenon that is otherwise invisible, and because that visualization is relevant to the rest of the explanation on human anatomy, it works as a curiosity-sparker instead of being a gimmick. This video also puts concepts (denaturization, skin anatomy, etc.) in a real-world context to make viewers see an otherwise familiar thing (skin) in a new, unfamiliar way.

Room to Improve: This video could have better explained these concepts with clearer overlays and visuals, but Derek’s earnest excitement works well in getting audiences to view hair and lasers in a new light.

World’s First Electric Generator (Veritasium) https://youtu.be/NqdOyxJZj0U

Good: Derek’s natural hosting and speaking style, mixed with a man-on-the-street format, helps create a hook that highlights the strangeness of this phenomenon. By having people predict the behavior of a magnet in a copper pipe, Derek engages audiences and makes familiar materials unfamiliar.

Caveat: Man-on-the-street videos can vary quite a bit in quality and rely heavily on a good host to avoid being corny.

Is Inheritance Really All In Our Genes? (It’s Okay to Be Smart)
https://youtu.be/81rFpRsF80c

Good: The premise of this video directly tackles misconceptions around epigenetics, genetics, and inheritance (the title is intentionally a bit misleading). Joe Hanson’s speaking, body language, and tone of voice is very natural.

Room to Improve: The script is a bit formal (lots of passive voice). I also think this video would have been just as effective as a blog post, with infographics and text.

The Backwards Brain Bicycle (Smarter Every Day) https://youtu.be/MFzDaBzBIL0

Context: Destin tries to ride a modified bicycle whose wheel turns right when the handlebars are turned left, and vice versa. Through the example of trying to ride an almost impossible-to-ride bike, Destin demonstrates the concept of neuroplasticity, or the brain’s ability to change and adapt.

Optimizing Video for Learning: A case study-based primer for informal, educational, digital video best practices
**Good:** Destin takes enough time through a clear, naturally-delivered script to emphasize how normal riding a bike is, before he makes you realize that riding a bike is actually very complicated. He executes this well with his natural and personal delivery, incorporating home footage of him learning to ride a bike as a child, in addition to having his young son involved, to emphasize the familiarity of riding a bike. Destin genuinely invests his YouTube persona into his community (encouraging participatory learning), too. A cross-collaboration with YouTuber Mike Boyd, whose channel features him learning new skills in as short a period of time as possible (https://youtu.be/oI2aMKwXxnE) broadens the invitation to more audiences to explore this curious phenomenon. The genuineness of his delivery invites viewers to see the strangeness of neuroplasticity and explore the phenomenon for themselves - a few viewers even uploaded response videos of them making their own backwards bikes - skyexplorers (https://youtu.be/x81ZbXxmcuA) and Maple Syrup (https://youtu.be/JEXr9VpU1SI).

**Can We Live in a World Without Microbes? (MicrobeWorld) [https://youtu.be/sax0Iaedl-Y](https://youtu.be/sax0Iaedl-Y)

**Context:** This video is part of the BioFilms YouTube webseries produced by the American Society for Microbiology. These short videos aim to make microbiology concepts accessible to the YouTube audience.

**Room to Improve:** This video, in theory, should work. It plays into the perception that microbes are bad, before making viewers rethink these “bad” microbes as things that are not only good, but actually essential. However, the inauthentic script that uses formal and technical language inconsistent with the informal format and style of the video prevents this episode from successfully sparking curiosity. Having the narrator speak naturally instead of reading off an awkward script might help establish authenticity. Distracting, amateur, and cheesy graphics and sound effects rarely provide audio/visual complementarity and read gimmicky instead of clarifying concepts. Poorly-executed humor distracts from the content.

**Digestive System, Part 1 (Crash Course) [https://youtu.be/yIoTRGfcMqM](https://youtu.be/yIoTRGfcMqM)

**Context:** Crash Course is a YouTube series produced by John and Hank Green, covering subjects like history, biology, chemistry, and philosophy.

**Good:** Hank opens with “both you and food are made of stuff, by which I mean matter made of certain kinds of atoms, and both you and food have energy stored in the bonds between those atoms.” While he never outright says “your body and food are a lot more similar than you realize,” this lesson on the digestive system tries to get viewers to see the familiar concept of food in a new, more curious way. The table of contents in the YouTube description is also helpful, where the video has been segmented into easily navigable “chapters.”

**Room to Improve:** Some of the on-screen text might overload viewers. Inserting points of interaction with viewers, asking them to make predictions or check their understanding of concepts, might help with pacing. Hank talks really fast - this is his natural talking style and personality, and this style of self-aware-internet-geek really appeals to his dedicated audience. But it’s also really fast and hard to follow when the content’s so technical.

**NASA 360 Presents - Game Changing [https://youtu.be/Oq1ZF0bKQEO](https://youtu.be/Oq1ZF0bKQEO)

**Room to Improve:** This profile of NASA’s Game Changing Development Program does little to make audiences rethink perceptions - we’re repeatedly told that the program’s projects are “game-changing,” but because we don’t really know anything about the “game,” it’s hard to appreciate how cool any of these projects are. Ceri Riley, a former student with whom I worked, one aptly noticed - “You have to teach the audience something before you can blow their mind.” This is an example of a payoff without a setup.

**Ice Cream Sandwiches | How It’s Made (Science Channel) [https://youtu.be/Vlb4mfQv6-s](https://youtu.be/Vlb4mfQv6-s)

**Good:** How It’s Made is a surprisingly successful broadcast television show with an extremely simple premise - go into factories, warehouses, machine shops, etc. and film how everyday products like ice cream sandwiches are made. It’s virality and popularity (the gifs made from show footage are incredibly shareable) play on the delight in viewers’ responses when the things that are so familiar to them are visually unpacked to reveal something very unfamiliar. It’s production style is extremely straightforward and simple,
and even though the narration tone and style is a bit formal, the visuals and audio are clean and clear enough to make everything easy to comprehend. Does it help people learn in a meaningful way? Who knows. But, judging from the comments, people are having fun watching and having their curiosity piqued.

Caveat: Remember that there is no one-size-fits all approach to video - this type of video works due to the combination of the production team and equipment available to Science Channel and their access to interesting factories. Setting up a phone camera to show how two chemicals mix together is not inherently interesting.

How Pixar uses Music to make you Cry (Sideways) [https://youtu.be/i8HePfa7WYs](https://youtu.be/i8HePfa7WYs)

**Good:** This is one of my favorite educational YouTube videos. The narrator is authentically passionate about the topic, expressed in his natural tone of voice, and he’s constantly using a “make the familiar unfamiliar” approach in his script. Instead of simply defining various music theory terms, he takes viewers’ misconceptions (“you should play sad music to make people feel sad, right?”) and flips them on their head in the context of real examples. His Internet aesthetic is consistent with the overall feel and tone of the video and his personality as an individual YouTuber.

Be authentic so you can convey the right emotions for your video:

**Why it can work:** “One of the greatest strengths of television and video is the ability to communicate with viewers on an emotional, as well as a cognitive, level” (Cruse 2007). Videos can motivate (Bravo et al. 2011) and spark curiosity (Koumi 2015) which primes the brain for learning (Gruber et al. 2014) and these stem from the emotions that video content can spark. Emotions are tied to learning (Meyer and Turner 2002, Kort et al. 2001, Bower 2014, Sylwester 1994) and personal connections to subjects featured in the video lead to favorable emotional involvement in the learning process (Karppinen 2005). Additionally, emotions most strongly associated with sharing include inspiration and surprise (Guerini and Staiano 2015).

**Pulling it off:** These favorable emotions - surprise, inspiration - are best facilitated by a delivery and tone that is **authentic, natural, and unforced**. The Viral Video Manifesto, written by multi-viral video producers of Eepy Bird Studios (Diet Coke and Mentos [https://youtu.be/h_2osOb2SMU](https://youtu.be/h_2osOb2SMU) is their claim to fame), argues that authenticity is one of the most important qualities that viral videos possess (Voltz and Grobe 2013). This is related to Mayer’s Voice and Embodiment Principles - that people learn more deeply when topics are explained in a conversational style versus a formal style, using first-person pronouns over the typical third-person, formal phrasing of journal articles, with natural body language and movement. Derek Muller also found that learners were more receptive to styles of speaking that weren’t forced (Muller 2008). The tone of delivery seems more important than an optimal words-per-minute that video MOOC research suggests (Guo et al. 2014).

**Caveat:** Videos with a tone of grandeur can effectively lead to inspirational emotions, and videos with humor can help establish a tone of approachability and authenticity, particularly with academic or technical topics (Jonas 2012, Nelson 2011). However, sense of grandeur and humor are extremely difficult to pull off effectively, and run the risk of alienating viewers who might find the attempts distracting, offensive, or unprofessional. Unless you have the personality and production capabilities to really tackle these two effects, my personal suggestion is to avoid them all together.

**CASE STUDIES:** Authenticity

Read between the lines (Science360) [https://science360.gov/obj/video/297770ee-3197-4f54-912f-bf175d897e04/read-between-lines](https://science360.gov/obj/video/297770ee-3197-4f54-912f-bf175d897e04/read-between-lines)

**Context:** This is part of a science news webseries for the public called Super Science Show, produced by the National Science Foundation.

**Room to Improve:** The hosting is forced, awkwardly injecting humor in a way that neither relates to the content nor encourages the viewer to keep watching. The lack of audio-visual complementarity makes it hard to understand the content. This might have worked better as a blog post or a video with b-roll of the labs and research highlighted, and better hosts.
Forest of Friendship, Baggage Carousel of Jerks (Veritasium)
https://youtu.be/-zShHRkwSoI

**Good:** Derek Muller’s natural speaking and hosting style help make content easier to understand. He also sets up the surprising/unexpected similarity of tree evolution to experiences at airport baggage carousels, genuinely sharing in the delight of uncovering this similarity with his audience. The understated music helps to evoke a curious tone.

Microbial Monsters - Algae, Vampirococcus and Halloween (MicrobeWorld)
https://youtu.be/tNxfzUreua4

**Context:** This webseries is produced by the American Society for Microbiology, aimed at promoting general interest and education in microbiology.

**Room to Improve:** The visuals - which generally don’t clarify or coincide with the narration - and topics of this video seem aimed for an extremely young audience (8-10 year olds), yet the language used is unnaturally formal. For example, the sentence: “Algae, the green slime you often see in lakes or along shorelines, is an informal term for a large group of organisms that range from single-celled microbes, such as cyanobacteria, to multicellular forms, such as giant kelp.” would more naturally be worded as: “Algae come in a lot of different forms - it’s the green slime that you sometimes see on lakes, but there are also tiny glowing bacteria and giant kelp that count as algae, too.” This video generally reads as inauthentic, fake, and corny.

What the Function? With Smarter Every Day! (The Brain Scoop)
https://youtu.be/9xBxhgMkETU

**Context:** This collaboration video between The Brain Scoop and Smarter Every Day features Emily quizzing Destin on various specimens in Chicago’s Field Museum and what their parts do.

**Good:** Emily and Destin are both exceptionally natural presenters - their tone of voice and body language invite viewers to share in a genuine enthusiasm and wonder for the world around them.

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**Use aesthetics to make content easier to understand and to establish tone:**

**Why it can work:** Unlike textbooks and other media, video allows viewers to experience visual and auditory material simultaneously. The key is to leverage these sights and sounds in a way that makes content easier to understand, not harder, and to evoke a look and feel most appropriate for your target audience. The aesthetics of a video - the look and feel - matter because they affect knowledge consumption and reflect the identity and values of the content creator.

Aesthetic design - the judgement, attitude, understanding, emotion, and values that designers manifest through color, typography, music, framing, lighting, and motion - has long been studied by industrial designers and the human factors/user experience field. Design can stimulate the senses to provoke user behaviors (Agoston 1920, Singh 2006, Vergyer 1993, Sonderegger and Sauer 2010, White 2016, Lindgaard and Whitfield 2004), elicit emotions, and by extension, facilitate learning (Hekkert and McDonagh 2003). Color, visual tone, and design affect learning environments (Stone 2001) - it would make sense that the learning environment of digital videos is also shaped by those elements.

Sounds and sights can also make the familiar unfamiliar - designs that balance novelty (making people see something in a new light) and typicality (allowing things to be recognizable) are ideal in industrial design (Hekkert et al. 2003). Similarly, leveraging video to help viewers see familiar concepts in a new light (through slow-motion footage, for instance) can be effective.

**Pulling it off:** The primary way to use aesthetics to facilitate learning is to maintain audio/visual complementarity - in other words, do the words and pictures relate to each other without being redundant (Koumi 2015, Mayer 2009, Muller 2008)? Do the visuals help clarify the words and vice versa? Visuals, sound effects, and music (or lack thereof) can provide cues when necessary, redirecting viewers’ attentions to important content - this has been an established best practice since the advent of educational television (Huston and Wright 1994). But be deliberate about what takes up screen real estate or that music and sound effects don’t end
up distracting viewers and keep Mayer’s principles of multimedia design in mind (p. 9).

Finally, the look and feel of a video can not only affect viewer learning, but they also reflect the identity of the content creator. While do-it-yourself and lo-fi production approaches are appropriate for YouTubers like Crazy Russian Hacker, that same approach should not always be used by university MOOC producers who cannot bring the personal level of authenticity and community engagement that makes these homemade YouTube channels work. It’s true that:

If your content isn’t strong enough to stand on its own without television-style production techniques, get better content. (Voltz and Grobe 2013)

And that’s exactly it - get better content. Write and deliver it in a natural, relevant way, instead of conflating muffled audio and fluorescent lights for authenticity. There’s a misconception in the literature that assumes low production quality causes authenticity, instead of simply having some correlation with it. For YouTubers and individual classroom teachers, whose content and personalities are compelling enough, a homemade, low-key approach can add to the approachable brand of the creator. The Applied Science and Smarter Every Day channels on YouTube are good examples of engaging viewers despite not having the slickest production quality - they’re able to make up for it by engaging with their communities of learning with very distinct, memorable, and authentic personalities and content. The Applied Science channel, in particular, has fairly low production value but the content is so compelling - very much about making familiar things really weird - and the talent is so quirky and authentic that he gets away with it. Some examples:

- Frying a potato chip in Fluorinert FC-40
  https://youtu.be/a4gYv2BK-HQ
- Cookie Perfection Machine
  https://youtu.be/8YEdHjGMeHo
- Your toothbrush is worn out!
  https://youtu.be/cwN983PnJoA

This approach, however, is not necessarily appropriate for university-produced MOOCs or services where learners are paying for credentials, institutions are upholding particular communications strategies and branding, and/or where there aren’t staff or people who can consistently be the “brand” and continuously interact with the audience. If you are representing a corporation, broader mission, university, etc., the aesthetics of your video will reflect something about who you are as one of these entities (in addition to the rigor and quality of the content, too). If you are trying to connect to particular audience demographics, the look and feel of your videos will affect these efforts. Aesthetics don’t just refer to the quality of camera or equipment and the technical proficiency with which they’re used, but rather how an intentional eye for design leverages sights and sounds to establish a fitting vibe and tone. Remember: a video can both be professional and authentic.

**CASE STUDIES: Aesthetics**

**Science of Golf: Work, Energy and Power (United States Golf Association (USGA))**
https://youtu.be/mnxesTctOPU

**Context:** This episode is part of a series produced by the USGA and NBC Learns on the science of golf.

**Good:** It contextualizes concepts in real-world, observable phenomena related to golf. The video is well-made from a technical standpoint, using slow motion footage to better illustrate what happens when a golfer hits a golf ball.

**Room to Improve:** While the production quality is extremely slick and professional, the actual animation overlays are sometimes visually gimmicky and don’t always clarify the narration. (They’re also conceptually misleading and not entirely accurate.) Talking head narrations violate the image principle, since they’re difficult to understand without visual clarification. Having long bodies of text like the actual definition of the law of conservation of energy on screen unnecessarily increase the cognitive load of the viewer and are difficult to process.

**The aesthetic:** This video series is very broadcast news-y and corporate, due to the lighting of interviewees, narration style, and over-the-top music.
Why Do Onions Make You Cry? (Reactions) https://youtu.be/RaZpPwmWZ7Q

**Good:** The premise of this video is built around a curiosity-sparking question related to real-world experiences.

**Room to Improve:** This video is essentially a series of slides of chemical names interspersed between b-roll of someone cutting an onion; it could have easily worked as a blog post with gifs or infographics. Instead of having footage of chopping an onion, animation overlays to show magnified onion cells breaking open to release enzymes and other labeled chemicals would have been more helpful.

**The aesthetic:** This is video has an extremely amateur and dated look and feel, which would be acceptable for do-it-yourself YouTubers or young student projects. It doesn’t inherently negatively impact audiences, but it does reflect an undesirable image for the American Chemical Society.

Let’s Look Inside Our Body (Kentucky Educational Television/Planet Nutshell) https://vimeo.com/152332117

**Good:** This simple introduction to anatomy and physiology for young children has great audio/visual complementary, color palettes, and musical and visual simplicity to make concepts as clear as possible (for example, darkening out the body outline when showing the spine).

**The aesthetic:** The understated voiceover and music, along with a muted color palette, create a tone that is playful and whimsical without being loud and obnoxious.

Newton’s Laws 3 - Third Law of Motion (Dr. Skateboard’s Action Science) https://youtu.be/B_xFFq6eTFs

**Good:** This video frames Newton’s Laws in the real-world, highlights a person of interest (“Dr. Skateboard” is a skateboarder and physicist), asks audiences questions and to make predictions, and includes simple visual cues and captions.

**Room to Improve:** The aesthetic - how it’s shot, the hosting style, the graphics, the music and sound effects - is very dated and too eager to make science cool and hip. In general, the design doesn’t motivate the objectives and the overlays are distracting and out of sync with the footage, leading to a weaker script and overall video.

**The aesthetic:** Dated and corny

Torque: Crash Course Physics #12 (Crash Course) https://youtu.be/b-HZ1SZPaQw

**Good:** The video opens with a misconception and equations and concepts are introduced in the context of this problem. Visuals relating to circular motion are clear and complementary. The host is natural and engaging.

**Room to Improve:** This is an example where a shorter video is not inherently a better one - the host flies through concepts so quickly, leaving very little time for audiences to process information or to make predictions of their own. This is particularly noticeable when she introduces equations, where text, visuals, and narration are all happening at once and very quickly. Her speaking speed and the pacing of her delivery are both very frantic. And while it’s nice that she recaps what concepts she went over at the end of the video, it might’ve also been beneficial to recap the key concepts/equations themselves.

**The aesthetic:** Clean, young, playful, fun, snappy

Lipstick | Ingredients with George Zaidan (National Geographic) https://youtu.be/kfKrPGfwqkl

**Context:** This series attempts to demystify the chemistry of everyday items and scary-sounding chemicals. The main production challenge was around packaging substantive chemistry in a way that’s accessible to average audiences.

**Good:** We used sidebars and visual cues to reinforce the concepts and types of chemicals,
which would otherwise be hard to remember. The hand drawn fonts and cartoon backgrounds help establish a friendly, approachable tone.

**Room to Improve:** We didn’t realize just how overwhelming the information was until the edit, so we finagled with the visuals in sections that we would have ideally re-shot all together. It resulted in a video that’s pretty dense, with some moments where the overlays, visuals, and narration overwhelm each other a bit.

**The aesthetic:** Playful, snappy, “adult Blues Clues”

c) Videos can encourage participatory and/or social learning and build identity:

Engage a community of learners and remember that digital video never exists in isolation. Think about distribution and how people will view your video from the very beginning of the ideation process.

**Certain types of interactivity are better.** Take advantage of the many ways users can now interact with content and content creators - those possibilities didn’t exist over 50 years ago when educational videos first emerged.

Keep it concise, not short, to maintain the audience’s attention. Use audio/visual complementary and a natural script structure - no need to be reading from a textbook!

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**Engage a community of learners and consider how people will view your video early in your production process:**

**Why it can work:** Online videos allow viewers to shift from “being passive consumers to active participants” by interacting with other viewers and producers (Welbourne and Grant 2015), which facilitates participatory and social learning (Brown and Adler 2008, Lenhart and Madden 2005, Mondrup 2014). While educational television had the potential to spark participatory learning among viewers, particularly with parents and children (Huston and Wright 1994), platforms like YouTube are spaces where creators and audiences make sense of material together (Trier 2007) and allow anyone to participate in the video experience. Digital video offers an opportunity for interactivity that’s fundamentally different from television - for that reason, in order to operate effectively as a participant in the YouTube community, it is not possible simply to import learned conventions... from elsewhere (e.g. from professional television production). (Burgess and Green, 2009)

User-generated videos on platforms like YouTube allow for self expression and open, accessible, compelling, unconstrained interactions that create tight-knit communities beyond merely a broadcast platform - these communities around video can play a significant role in shaping an individual’s identity (Milliken et al. 2008, Bull et al. 2008, Jones 2008, Rotman and Preece 2010, Tan and Pearce 2011, Meyers et al. 2013). This point is particularly salient in the context of research that suggests that self-identification as a STEM-capable individual and a positive attitude toward STEM in middle school is one of the strongest predictors of if a student will pursue a STEM career (Tai et al. 2006, Maltese and Tai 2010, Cleaves 2005, Kidd and Naylor 1991, Robnett and Leaper 2012). General learning sciences research highlights the importance of self efficacy and self confidence as a learner (Zimmerman 2010); video can encourage among young people in developing that self confidence. On top of that, well-executed educational video has been shown to be able to change viewers’ attitudes (Fortner and Lyon 1985, Gerbner 1987).
Pulling it off: A video and where it lives can’t be separated in the digital age. Distribution channels and social engagement aren’t just marketing considerations to tack on at the end of video production. I have a bad habit of just focusing on the actual video first and where I’ll post it only after production wraps. Build video by thinking of its integration into social media, or a class, etc. from the very beginning. Chris Dixon uses the phrase “Come for the tool, stay for the network” to describe the power of networks and communities in creating long-term value for consumers, which corroborates the idea that video’s power is derived not from the physical tool, but the community it facilitates (Dixon 2015). Ideally, you’d gather your content expert, multimedia producer, community expert, and instructional designer (a single person could fulfill multiple roles, but keep in mind that these are very different domains of expertise) at the beginning to understand how your video will come together.

Thinking about the social and digital context in which your video will sit can be useful simply for logistical considerations:

- Will you be distributing your video on a technological platform that has certain restrictions? (i.e. Panopto is incompatible with edX, as are choose-your-own-adventure videos. PBS Learning Media also currently does not support 360 virtual reality videos or videos with annotations.)

- How do I want audiences to be able to engage with my content?
  - Low-cost live video options include Facebook Live, Google Hangouts, YouTube Live, Periscope, and Meerkat, but they each have different benefits and downsides depending on the scope and objectives of your experience.
  - Platforms like FlipGrid allow students to engage through their own video “comments” in a video community (Devers et al. 2016)
  - If you’re posting on YouTube, will you be able to engage with your audience to the degree of successful YouTubers? Part of why channels like Art Assignment and SciShow have become so successful is because John and Hank Green have built a huge and loyal community of followers with VlogBrothers and maintain genuine and personal investment in their fanbase (at least it seems). Buzzfeed video works largely because their creators are in the same demographics as their consumers. How will you engage your community?
  - Is your video intended to replace classroom lectures entirely, or more for blended learning? If you’re a just-for-fun YouTuber, there’s definitely more room to play than if your students are being tested on concepts.

Just as distribution isn’t a last-step consideration, no single design process neatly falls into a certain place in the pipeline of video production - as you consider these questions, you might have to rewrite your scripts, rethink your video format, or fundamentally rework your content. As you implement an aesthetic, you might have to adapt your script or distribution channel to match. Video production is a highly iterative and often circular process, which is why considering seemingly tail-end strategies like “where will people watch this video” during pre-production is important and very useful. Elements of the video production process all influence each other - writing affects aesthetics which re-affects writing, hosting, design, distribution, community engagement, and so on.

CASE STUDIES: Community Engagement

Karina Garcia channel
https://www.youtube.com/channel/UCTTMptGhJ67e40DTqNw

Context: This arts/crafts and makeup YouTube channel has over 2 million subscribers, dedicated followers who offer each other tips and tricks and send episode requests to Karina. She frequently promotes other YouTube creators who make videos on similar arts/crafts projects.

Good: While they may not resonate with everyone, Karina’s videos and her YouTube community are inseparable - her videos would not have the same type of impact if isolated from the community that the platform facilitates.

Caveat: Directly applying this style of community engagement is not necessarily best for all scenarios - this works largely due to Karina’s personality, the DIY projects she guides her viewers through, and her ability to be the face to her name, engaging with the channel 24/7.
The Art Assignment channel https://www.youtube.com/channel/UCmQThz1OLYt8mb2PU540LOA


Good: Due to the frequency with which they can interact with viewers, The Art Assignment is a great example of leveraging the social aspect of video to get viewers contributing, making, and learning. It’s also an example where meeting audiences where they are may be a substantial enough reason to justify video use. The projects shown and stories told on the channel could just as effectively be disseminated through blog posts and print media, but the benefit of making them as videos is that the channel is able to introduce art and art history - conceivably “elite” and “serious” topics - in the informal setting of YouTube. But, once again, The Art Assignment makes this work because Sarah considers the videos in the context of YouTube from the very beginning - they’re created with their online home in mind, they’re not made for the classroom/donors/etc. and then posted on YouTube as an afterthought.

SciShow channel https://www.youtube.com/user/scishow/featured

Context: This YouTube channel has over 3.5 million subscribers and posts science-related videos on curiosity-driven questions and science in the news. They publish different styles of videos every day (Tuesdays are for “Quick Questions” and Fridays are for science news). Creator Hank Green is brother to John Green (of The Art Assignment) - together, they amassed a dedicated following on their channel VlogBrothers before launching Crash Course (another educational YouTube channel), Hank’s SciShow followed shortly after.

Good: Hank Green is one of the most well-known YouTube community members - aside from founding SciShow, VlogBrothers, and Crash Course, he also founded Subbable, a subscription service to help YouTube creators crowdfund, and VidCon, the largest YouTube fan convention that regularly draws tens of thousands of attendees. So, not only is he the face of this channel, but he’s also a well-known advocate for the YouTube community. He regularly interacts with fans and viewers through the channel itself - user suggestions sometimes drive future video topics - other social media channels, his tumblr, etc. Hank and John have a community fan-base of dedicated “Nerdfighters,” many of whom openly write about the empowerment that the Nerdfighting community has given them. This is all to say that the “SciShow experience” encompasses much, much more than the videos themselves, something that the channel creator spends an enormous amount of thought and time cultivating.

Learning Creative Learning http://learn.media.mit.edu/lcl/

Context: Researchers in the MIT Media Lab’s Lifelong Kindergarten group facilitate this online community with seminars, activities, and readings around building creative learning experiences. Students can join cohorts to go through materials together or at their own pace and users connect through platforms like UnHangout, a modification of Google Hangouts that allows students and instructors to connect via live video.

Good: Live video events like Google UnHangouts allow audiences to participate in the creative experience of the video (Hansch et al. 2015). This “course” uses live, online video to support and connect communities of online learners, to facilitate interest-based discourse in small break-out groups, and to spark discussion of jointly-watched video content.

The Truth About Toilet Swirl (Smarter Every Day with Veritasium) http://www.smartereveryday.com/toiletswirl

Context: This double-video collaboration was an experiment between US-based Destin of Smarter Every Day and Australia-based Derek of Veritasium to see if water really swirls differently in different hemispheres.
**Good:** This could have been a single video using splitscreens. However, this was an interesting opportunity to collaborate across two different communities - the two channels’ fan-bases - and was a very novel manipulation of digital, social video. The music and look and feel is polished yet understated enough to feel authentic. Both Destin and Derek have very engaging and authentic deliveries of this curiosity-sparking phenomenon.

**Caveat:** I’m not sure how much this format actually encourages learning, but it seems to have delighted and sparked interest in their communities of viewers and tries using digital video in a very transformative way.

**Certain types of interactivity are better:**

**Why it can work:** Multiple studies have suggested that video facilitates learning by making it possible for learners to actually interact with content (Zhang et al. 2006, Merkt et al. 2011). However, there’s a fine line between engaging viewers and burdening them with unnecessary cognitive load and distractions.

**Pulling it off:** Interactivity should be built into the design of the video itself (consider them in your writing, filming, etc.), not as an add-ons after video production is complete. For example, Harvard’s CS50 course developed a video player to add interactivity with features like questions overlaying on top of the video, but they ended up just distracting students (MacWilliam et al., 2013). Similarly, separate, on-screen table of contents or glossaries don’t really benefit learners (Merkt et al. 2011). However, I think simple, off-screen table of contents can be helpful, like the clickable ones built into the Crash Course (https://www.youtube.com/user/crashcourse) video descriptions. Interactions that are useful are ones that:

- Are simple: being able to start/stop/replay videos is one of the most useful interaction points (Merkt et al. 2011)
- Prompt viewers with questions - specifically, having viewers make predictions is helpful (Crouch, Fagen, Callan and Mazur, 2004)
- Allow viewers to advance topically whenever they’re ready (Mayer’s “Segmenting Principle” in his 12 multimedia principles - Mayer 2009)

**CASE STUDIES: Interactivity**

**MIT's Choose-Your-Own: Chemistry Adventure (MITK12Videos)**
https://youtu.be/pRc4FxrNGyY

**Context:** By using YouTube’s annotations and cards, viewers can choose their own viewing path through this video series, manipulating various ingredients in a chemical reaction.

**Good:** We wanted to be very deliberate and conservative with the use of the choose-your-own-adventure format, knowing that it could easily distract or lose viewers. The underlying topic - scientific inquiry and methods - inherently lends itself to a choose-your-own-adventure format, so it made sense to use this format for this particular content. This video series asks viewers make predictions based on concepts illustrated in the series.

**Room to Improve:** Because we didn’t want to lose viewers as the videos progressed, we tried to keep them very short - under 2 minutes each. That meant breezing through some concepts, maybe too quickly. The host probably didn’t need to be on screen for some of the animation shots to better align with Mayer’s Image Principle, which suggests keeping the speaker visible on-screen only when there’s a specific reason to have them visible (Mayer 2009). We haven’t finished collecting data on user reactions, so it’s unclear how much this level of interactivity helped versus hindered learning.

**Making It Personal: Using DNA to Tailor Cancer Treatments (BLOSSOMS)**
https://blossoms.mit.edu/videos/lessons/making_it_personal_using_dna_tailor_cancer_treatments

**Context:** This ~18 minute video explains how researchers look for DNA mutations in cancer cells and how it affects treatment for patients. It’s designed to be shown in classrooms in blended learning settings and builds in short breaks so students can discuss question prompts sprinkled throughout the video.
**Good:** This video contextualizes biology topics in real-world research and encourages viewers to make predictions. It allows expert guest speakers to basically remotely lead a classroom lesson.

**Room to Improve:** The hosts sometimes speak unnaturally, largely due to an uncomfortably formal script that has an awkward flow of material. The video could benefit from more audio/visual complementarity and many of the slides show dense graphs that would make more sense in a non-video setting, where viewers can process data at their own pace. Visual cues and markers could help ease some of the cognitive load I was experiencing as a viewer. The aesthetic (framing, lighting, music) is dated, and the content could better spark curiosity.

**How Virtual Reality Works (MITK12 Videos) [https://youtu.be/-Kovxf6g0mo](https://youtu.be/-Kovxf6g0mo)**

**Context:** Viewers can watch this episode in virtual reality by opening the YouTube app in Google Cardboard or in 360 in the YouTube desktop site.

**Good:** We thought the best way to explain the technology behind virtual reality was through an actual 360 video. We knew this format might also be unnecessarily distracting and gimmicky, so we also attempted to keep the visuals as simple as possible, adding cues to direct viewers’ focus to objects of interest. We also kept the script and delivery as natural as possible to prevent making the topic any more technical that it inherently is.

**Room to Improve:** The 360 video was not necessary for all parts of the video, but because of technical restrictions of YouTube and the editing software, the whole episode had to be uploaded that way. This might make certain parts of the explanation more distracting than if they were traditional video or text. One potential workaround might be to create a website page that uses a collection of text, 360 video, and images.

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**Keep it concise, not short, to maintain the audience’s attention:**

**Why it can work:** Recommendations for the ideal length of educational video range from 5 minutes (Guo et al. 2014), 5-10 minutes (The State of Video in Education 2015) to 15-20 minutes (Nelson 2011). Welbourne and Grant recommend that further research on video length is needed (2015) due to a lack of agreement on what “shorter” really means. However, a 5 minute video won’t hold an audience’s attention if it’s poorly written or poorly hosted - but a concise video will.

**Pulling it off:** Instead of being guided by a universal time limit and making videos as short as possible, videos should convey ideas as **concisely** as possible. A video that takes some extra time to engage and interact with viewers may be more effective than one that artificially shortens itself with a host talking too fast and densely compacting material into a shorter length. Studies and surveys that suggest that short videos are better often overlook the possibility that viewers stop watching not because a video is long, but because it’s bad - that the presenter is isn’t engaging, the script is dry, the video does not motivate the viewer to continue watching, or that it’s simply not a helpful video. Take the opportunity to reimagine lectures and lessons from scratch when you create an educational video, instead of just filming a sped-up lecture.

An effective strategy when presenting complex topics is to present things in chaptered or segmented chunks (or separate videos) to help viewers process material, like acts in a play (Koumi 2015, Mayer 2009).

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**CASE STUDIES: Conciseness**

**Digestive System, Part 1 (Crash Course) [https://youtu.be/yIoTRGfcMqM](https://youtu.be/yIoTRGfcMqM)**

**Context:** Crash Course is a YouTube series produced by John and Hank Green, covering subjects like history, biology, chemistry, and philosophy.

**Good:** This ~11 minute video has a clickable table of contents in its YouTube description, where it’s been segmented into easily navigable “chapters.” The script, visual style, and hosting help make the familiar (your gut) unfamiliar, sparking curiosity even though this is essentially just an online lecture.

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**Optimizing Video for Learning:** A case study-based primer for informal, educational, digital video best practices
Room to Improve: Some of the on-screen text is overwhelming. Interacting with the audience more by asking them to make predictions or check their understanding of concepts might help with pacing. Hank’s super fast speaking style is also hard to follow. Personally, I’ve noticed a very conspicuous divide between audiences who like Hank’s style (teens and millennials) and those who don’t (anyone over 35).

Cellular Respiration (Bozeman Science)  https://youtu.be/Gh2P5CmCC0M

Context: Paul Andersen is a high school biology teacher who uploads simple video lessons for high schoolers. They aren’t very flashy and are usually used by students who need to pass some sort of exam. His videos range between 4 and roughly 15 minutes; this one is 14:13.

Good: Paul is an experienced teacher, which shows in his natural and comfortable delivery. Though this video is way over 5 minutes long, he uses this extra time to clearly explain the mechanics of cellular respiration. It’s meant for already motivated learners (students studying for the AP Biology exam, for example) and he gives them the information they need while subtly incorporating real-world applications and misconceptions.

Room to Improve: Some of the explanations feel a little rushed - Paul could have actually taken more time or segmented the video by sub-concepts. Generally, this format of video isn’t a very innovative - the reason why this video works is because of Paul’s experience in engaging his very specific audience.

Vsauce How Earth Moves  https://youtu.be/IJhgZBn-LHg

Good: Even though this is a 21:36 long video, it keeps audiences engaged by effectively making the familiar (sun rises, Earth’s orbit, etc.) unfamiliar. Several of Vsauce’s videos are over 20 minutes long, yet this YouTube channel has over 10.5 million subscribers with each video getting multiple millions of views. While Michael Stevens has a very particular hosting style that may some viewers dislike, it’s very true to his personality and, therefore, authentic. The music is subtly evocative and the visual style reflects the Vsauce personality while still looking clean.


Context: This is an 8-video series produced for the edX massive open online course, Cellular Solids 1: Structures, Properties, and Engineering Applications.

Good: Hosted by Professor Lorna Gibson, this series combines a person of interest with contextualized research as she explains the material properties that allow woodpeckers to peck and fly. The videos are cleanly and professionally produced.

Room to Improve: The videos seem to be segmented by time rather than by concepts. The extra time spent recapping and looking ahead makes the collective series (which is over 20 minutes) longer than if it had been a few concise videos. The videos might better pique curiosity if they took extra time to highlight just how crazy it is that woodpeckers can withstand so many forces, instead of diving straight into the mechanics of how they fly and peck. While the production techniques are professional, it has a more traditionally television and less internet aesthetic in its music and visuals.
Several studies have suggested that when students produce educational video, the production process itself can boost their engagement, self-expression, and creativity (Schuck and Kearney 2006, Grace and Tobin 2002, Hakkarainen 2007, Ranker 2008) and can act as a means of civic engagement (Goodman 2003). Students can use video as a tool to communicate, observe, and reflect, and in the process, develop media literacy skills, communication and presentation skills, and self-esteem (Schuck and Kearney 2006).

However, video production does not necessarily help students gain content or media production mastery (Schuck and Kearney 2006). We’ve known for a long time that one of the best ways to learn something is to teach it (Frager and Stern 1970), but that doesn’t necessarily apply to teaching through video. Contrary to what we’d like to believe about student learning through video production, Schuck and Kearney found in one study that:

Relatively low levels of rigorous conceptual development relating to curriculum areas were noted… For example, students’ presentations of their final product often showed little evidence of any meaningful understanding of targeted concepts as they read from notes and avoided using their own words to explain concepts… Indeed, sometimes the technology seemed to be impeding conceptual understanding outcomes (Schuck and Kearney 2006).

I also noticed this when teaching a month-long educational media production course for MIT undergraduates and graduate students. Educational media production involves so many different kinds of fluencies that it’s difficult to expect students to master all of them. This is why I disagree with Hakkarainen’s suggestion that “university students can be engaged in the production of educational [digital videos] for university teachers” across the board (Hakkarainen 2007) - occasionally, you might find a particularly talented student, but banking on students to learn how to become video producers for other students is a much taller order than many assume (Sweeder 2007).

There’s a big difference between self-expression/practicing creativity and actually producing a great educational video because taste is required to leap from literacy to mastery. Silvia Gherardi argues that

Practice is much more than a set of activities—it involves, beside instrumental and ethical judgements, taste and appraisal. Taste is a sense of what is aesthetically fitting within a community of practitioners—a preference for ‘the way we do things together’. Taste is based on subjective attachment to the object of practice and is learnt and taught as part of becoming a practitioner; it is performed as a collective, situated activity within a practice. The elaboration of taste and the refining of practice within a community involves taste-making, which is based on ‘sensible knowledge’ and the continual negotiation of aesthetic categories (Gherardi 2009).

Understanding principles but then being able to execute them successfully with your own ideas are two very different things, at least in my teaching experience. Deliberate practice and skills building isn’t enough to develop taste - in order to go from proficiencies to creating this deliberate aesthetic and taste, the student has to have some combination of innate talent and/or more extensive
apprenticeship with skilled practitioners to develop a good eye (Macnamara et al. 2014).

**Pulling it off:** Video production is a great exercise for students when your objectives are geared toward literacy over proficiency (i.e. do you want students to be aware of what goes into creative communication and be able to critically analyze it, even if they can’t necessarily pull off a great video by themselves?), and more toward self-expression and creativity.

Have students focus on just a handful of fluencies required to produce good educational videos, but not all. In my course, I chose to focus on having students learn how to critically analyze videos, become generally knowledgeable in production techniques, and develop self-confidence in the creative expression of their ideas. I left little time for them to develop the taste to create a great final project suitable for public audiences, nor did they develop as deep content expertise as you might expect. But by focusing my learning objectives, students could have a meaningful learning experience that centered on personal growth around those skills and appreciation for digital media production (Choe and Goldstein, 2015). I also chose those goals because my students had never worked with video before and were all science and engineering students whose interests were in broadly communicating to non-technical audiences. Depending on your students’ backgrounds and interests, pick the handful of fluencies most appropriate to them. In other cases, it might be better to focus on the technical elements of production and less on speaking in front of a camera.

It can be tricky to evaluate and grade creative work - in general, peer assessments are important as exercises to learn how to critique, but often fail to give useful feedback to the student receiving them (Hakkarainen 2007). Instead, self-reflections are a great tool for you to gauge how students are learning from production experiences, whether it’s through daily blogs like we used in our class, self-reflection video blogs, or some other form of journaling (Choe and Goldstein 2015, Schuck and Kearney 2006).

Teachers work best as facilitators and editors (Schuck and Kearney 2006), but having the perspectives of a team of guest lecturers and practitioners - coaches with good eyes and taste - simulate condensed versions of apprenticeship for students and worked well for us (Choe et al. 2015).

**1. Why should I make a video?**

**summary:** Videos should be transformative instead of simply transmitting a traditional lecture or learning experience.

These videos are on the exact same topic (position, velocity, and acceleration) aimed at the same audience (introductory physics students). What strides have we made in educational video in the last 55 years?

**THEN (1960)**

**Straight Line Kinematics**

*(Educational Services - The Physical Sciences Study Committee)*

https://archive.org/details/4131_Straight_Line_Kinematics

**Context:** In the late 1950s, a group of physicists, led by MIT professor Jerrold Zacharias, formed the Physical Sciences Study Committee (PSSC). They produced pioneering textbooks and educational materials for high schoolers around the world, including over 50 educational films like this one.

**Good:** Professor Everett Hafner uses a clever device and a car to show how position, velocity, and acceleration can be seen and measured in the real world. His demo and script is fairly natural (for its time, anyway) and all the visuals clearly complement what he’s saying. Even though educational movies were just emerging when this was produced, this one already reimagines the possibilities of delivering a lesson without the constraints of a classroom.

**NOW (2015)**

**Velocity Graphs (RICE AP Physics 1)**

https://youtu.be/GiQIwSh5nJI

**Context:** This video is part of the edX course, AP Physics 1.

**Comment:** It’s fascinating - and a bit depressing - to see how little educational media has changed in 50 years. The main difference is how videos are delivered - this one sits in the context of the edX platform, complete with self-paced lessons, example problems, forums, and transcripts. It’s freely available for anyone around the world to watch, whenever, wherever. But it basically covers the exact same content as the PSSC video; the PSSC video is arguably more interesting and innovative. I’d like to see video production adapt to the new capabilities and insights of multimedia that have emerged since the 1950s - what if the lecturer posed more questions to the audience? Could he get the audience more interested by addressing misconceptions? Does all of it really need to be a video?
Videos are resource-intensive to create and run the risk of adding unnecessary cognitive load to learners. Use it when everything else - live lecture, other multimedia, creative print pieces, infographics, audio podcast, text - won't cut it or aren't viable. Video can offer great learning experiences when produced well, particularly when you take advantage of its ability to transcend space and time. Ideally, your use of video should create an experience that's meaningfully different from a live lecture or classroom experience. Live-streaming videos of lectures and events - which seem like just projected lectures - can be effective tools when coupled with social elements that allow for participants to interact and engage through chats (Hansch et al. 2015). Tools like Google Hangouts, YouTube, Facebook Live, etc. make it fairly easy to try live video if you’re an instructor without a lot of resources to produce video (Knuffke 2016).

Video provides a chance to re-imagine how content could be delivered without the constraints of traditional lectures. Avoid slapping on the bells and whistles of video production without fundamentally adapting your content to live in a digital space. Even the creators of technologies like lightboards (https://youtu.be/N1I4Afti6XE) emphasize that lightboards shouldn’t be just gimmicky ways of replicating lectures to the online space (Birdwell and Peshkin 2015), but should be used when other options/resources don’t exist or can be used in a way that offers meaningful and unique clarity to explanations. Lightboard videos work when an instructor is solving a particular kind of problem for people preparing for exams, but they don’t inherently spark curiosity. Producers should also be mindful of not violating Mayer’s Image Principle with lightboards - simply having a person on-screen does not always lead to learning.

**Good reasons why you’d want to make a video are:**

- I have a rare, limited resource (i.e. an expert in the field) who is extremely charismatic and whose personality/unique experiences can and should be shared with the world
- I want to evoke an emotional response from my audience (i.e. sense of wonder, curiosity) and the visuals, music, and other plastic elements of video can help me do that
- A video will allow me to visualize an abstract concept for learners more effectively than photos or gifs
- Video is the most efficient way for me to get information to the audience who needs it (i.e. a teacher recording a quick, vlog-style explainer video just for the class) - see Knuffke 2016

**Other arguments:**

- My communications strategy is specifically to engage demographics that dominate digital video spaces like YouTube
  - A related argument: My target audience is consuming information specifically via digital video
  - A follow-up: Why?
- Video is the most efficient way to collect and disseminate my content (i.e. recording a classroom observation for teacher training or a procedure is more effective than describing them in words alone, which could be more cumbersome)

**Weaker arguments** (which need to be beefed up with other arguments or a more robust analysis of your motivation):

- YouTube exists and lots of people use it, so I should take advantage of it
- Why not?
- Things that have gone viral were videos and I want to go viral
- It’ll be easier to make a video than anything else
- I want to engage people and video is flashy
- Video is a convenient way for people to consume information
2. WHAT’S THE POINT OF MY VIDEO?

Videos should deliver stories - not only a topic, but also why that topic is interesting.

A common mistake when making educational videos is mistaking the topic of a video for the point of a video. Videos should be more than a glorified textbook and make viewers walk away with a memorable story.

Pulling it off: Cartoonist and writer Jessica Abel’s Out on the Wire is an illustrated look at the storytelling approach of popular podcasters and radio show producers. In it, Alex Blumberg, who has produced for This American Life, Planet Money, and Start Up, explains the initial ideation phase of finding a story:

You simply tell someone about the story you’re doing, adhering to a very strict formula: “I’m doing a story about X. And what’s interesting about it is Y.” It’s important… that you do this out loud, to a real person. (Abel 2015)

“X” is the topic, which content creators often mistake as being the point of the video. “Y” is the justification behind why anyone would care enough to watch the video. Another way to think about it is that “X” is the familiar - the digestive system, differential equations, Newton’s laws, etc. - your audience has certain notions about these topics. “Y” is the unfamiliar - how will you make your audience see these topics is a new way?

These examples show the difference between videos with a topic (the digestive system) and videos with a point (your digestive system and the food it processes has more in common than you realize):

**CASE STUDIES: Making a Point**

**Digestive System, Part 1 (Crash Course) [https://youtu.be/yIoTRGfcMqM](https://youtu.be/yIoTRGfcMqM)**

**Good:** Hank never outright says “your body and food are a lot more similar than you think,” but this is the point (or “Y”) of this video. This video effectively engages viewers even as a lecture confined by a “standard curriculum” by approaching content using the familiar/unfamiliar strategy and getting learners curious about the digestive system beyond just defining terms.

**Room to Improve:** The on-screen text is occasionally overwhelming. Also, Hank talks really quickly (which is his natural talking style). Inserting points of interaction with viewers, like asking them to make predictions or check their understanding of concepts, might help with pacing.


**Room to Improve:** This video is intended for viewers who have some inherent motivation to learn various terminologies relating to the digestive system, but doesn’t really try to engage or spark audience’s curiosity. It is a topic-driven video, simply going through the various organs of the digestive system and defining terms. It simply defines anatomy terms. There are several moments when the visuals don’t complement or relate to the audio, the visuals don’t make verbal content any clearer, and the labels are difficult to read.

The narration and writing is also very formal, using unnecessary jargon and passive voice. Whiteboard animations can occasionally work, but I find that many videos in this style are ineffective and gimmicky because creators use it arbitrarily instead of using it to uniquely and helpfully convey concepts. In this case, the animated images are much more distracting and harder to understand than stills paired with text.
**Digesting Food (khanacademymedicine)**  [https://youtu.be/v2V4zMx33Mc](https://youtu.be/v2V4zMx33Mc)

**Good:** This video tries to connect understanding digestion to understanding childhood nutrition and the narrator gives a mostly-natural delivery.

**Room to Improve:** I personally don’t find the Khan Academy format a meaningful use of the transformative nature of videos. By the end of the video, I find the visuals quite overwhelming and my curiosity is not really piqued. I can see this video mainly being used by a student who needs to regurgitate this information for an exam.

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**The Digestive System (Bozeman Science)**  [https://youtu.be/nM5kMSjBrmw](https://youtu.be/nM5kMSjBrmw)

**Context:** Paul Andersen is a high school biology teacher who uploads his tutorials for science high schoolers around the world. The videos have low production value but are designed to help students in the classroom better understand concepts they usually get tested on at school. His videos range between 4 and roughly 15 minutes.

**Good:** This is more an example of good teaching more than it is a good video. Paul is an experienced and effective teacher, which shows in his natural and very comfortable delivery. He opens with some interesting “trivia facts” about different types of digestion found in other animals and makes the familiar unfamiliar by saying that the big picture of the digestive system is that it’s just a big hole where food moves through your body. He also unpacks the phrase “you are what you eat” in the context of digestion and clearly shows viewers what they should be able to understand by the end of the video. He speaks naturally and slowly enough.

**Room to Improve:** Some of the on-screen visuals are a little overwhelming and it’s not always necessary to have Paul’s face on screen. However, because he’s such a good teacher, this isn’t super problematic for this particular video.

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**Digestive System (Iken Edu)**  [https://youtu.be/i5MH6ddyi74](https://youtu.be/i5MH6ddyi74)

**Good:** This video leverages high production value animations to make the invisible visible. Clear audio/visual complementarity and anatomy labels make it easier to see the parts of the digestive system. Chapter cue cards reinforce topics.

**Room to Improve:** The sound effects are extremely distracting and the cue cards are very redundant, literally repeating the exact words that were just spoken. Like the Khan Academy video, this was clearly created for viewers who need to be able to regurgitate this information for an exam or already have some motivation to understand the material. While the information is very clear and easy to consume, it does little to ensure that learners will be able to retrieve or apply this information to future thinking beyond defining terminology - the tone of voice is very unnatural, concepts are isolated to just their definitions, there are no curiosity-sparking elements or efforts to engage viewers, and there is no ultimate point to the video beyond its topic. This is essentially an illustrated glossary that would arguably be more effectively presented via print, as Koumi recommends (Koumi 2015).
3. WHO IS MY AUDIENCE?
Pick a specific audience, know where they’re coming from, and talk with them.

In everyone’s ideal world, their content will empower self-motivated students, inspire the young people and apprehensive learners, and engage parents and kids alike (and maybe inspire generous donors while they’re at it). In reality, you should pick one or two strategic audiences, based on your resources and capabilities. A targeted video may end up appealing to multiple audiences, but it’s much harder for a broadly-targeted video to appeal to any specific audience.

Pulling it off:

• It’s a given that your content should be age-appropriate, so know your audience’s conceptual understanding of and exposure to topics and phenomena. Mayer’s Pre-Training Principle suggests that narrated animations work better when viewers have already been introduced to names and main concepts somewhere else in their life or earlier in the video (Mayer 2009). What is familiar to your audience and how can you connect your content to that?

• Talk with your audience, not down to them - though your audience doesn’t need to hear loads of jargon, your tone of voice and script shouldn’t be patronizing, either. Maintaining authentic delivery through natural writing and speaking (Mayer’s Personalization, Voice, and Embodiment Principles) is crucial.

• The more specific your target audience is, the better - “a highly self-motivated high schooler who’s exploring careers in biology research” is much more specific than “teens” and will make your production process much more effective. Same is true for “well-educated, intellectually curious, middle class, social media-active millennials” versus “millennials.” The actual audience is entirely up to you, based on your expertise and what you have to offer.

• Finally, target audiences through your aesthetic - the way you present content.

CASE STUDIES: Audience

Audience: Motherboard is a production of Vice, an “edgier” publication brand encompassing news, music, tech, and culture targeted toward millennials interested in current events and who are internet savvy. The music, color-grading, pacing, and hosting style creates a brand image that is serious and cold.

Audience: Nat & Lo are Google employees who produce video interviews with Google researchers and post them on their YouTube channel. It’s an example of polished informality - it maintains the authenticity of DIY YouTubers, while still being professional. The animation style, color-grading, pacing, and hosting style create a playful and whimsical tone geared toward audiences as young as 12 to lifelong learners who are curious to get a behind-the-scenes glimpse of Google.

Even though the formats of both of these videos are the exact same (in-the-trenches interview), their aesthetics are very different and neither style is inherently better than the other. I think each is appropriate and specific enough for their corresponding brands, though Motherboard’s approach makes me much less inclined to share, engage, or be curious, perhaps due to my personal distaste of the hosting style.
Microbial Monsters - Algae, Vampirococcus and Halloween (MicrobeWorld)  
https://youtu.be/tNxfzUreua4

**Audience:** This webseries is produced by the American Society for Microbiology for the general public, aimed at promoting general interest in microbiology.

**Room to Improve:** The visuals - which, for the most part, don't clarify or coincide with the narration - and topics of this video seem aimed for an extremely young audience (8-10 year olds), yet the language used is unnaturally formal. For example, the sentence: “Algae, the green slime you often see in lakes or along shorelines, is an informal term for a large group of organisms that range from single-celled microbes, such as cyanobacteria, to multicellular forms, such as giant kelp” would more naturally be worded as: “Algae come in a lot of different forms - it’s that green slime you see on lakes, but there are also tiny glowing bacteria and giant kelp that count as algae, too.” This video generally reads as inauthentic, fake, and corny because it’s trying to appeal to too many audiences - young kids, curious adults, biologists - and the visuals end up talking down to viewers.

Space Rocks (Royal Observatory Greenwich)  
https://vimeo.com/141677061

**Audience:** This is a visually beautiful animation of the difference between various types of space rocks that seems to target elementary-middle school audiences.

**Good:** The aesthetic is fun, whimsical, and airy without being overly cutesy. Humor is subtly injected with sound effects but isn’t too indulgent since the narrator keeps a normal, natural tone.

**Room to Improve:** The aesthetics are almost perfect, but the content is a bit confusing - the script is essentially a bunch of facts randomly strung together without a cohesive narrative and has a very abrupt ending. I kept watching because I was so enamored of the visuals, but I ultimately just ended up learning definitions of a couple terms.

A Sketchy History of Pencil Lead (Skunk Bear)  
https://youtu.be/lrZMSyhzcXg

**Audience:** Skunk Bear is one of NPR’s science blogs and YouTube channels, created by Adam Cole. The Tumblr and Wes Anderson aesthetic seems to be targeting Millennials and news-savvy young adults.

**Good:** From a technical standpoint, this is a beautiful and exceptionally produced video. The visual style and pencil-drawn animations are whimsical and delightful, answering the viewer-submitted question, “How is pencil lead made?”

**Room to Improve:** Though this is really a lovely video, a lot of the visuals don’t actually clearly depict what Adam’s saying (especially in the second half when it’s showing a pencil factory). The writing is mainly the issue - it might work for a written article or NPR blog post, but it’s actually kind of hard to understand in the spoken form. Again, it’s nicely made for just pure visual enjoyment, but isn’t really optimized for learning. Interestingly, the blog post about the video (http://skunkbear.tumblr.com/post/151750265389/to-watch-the-entire-process-in-detail-and-to) which just features gifs of the pencil factory, more effectively conveys the ideas, in my opinion.
4. WHAT DO I WANT MY AUDIENCE TO DO?

**Good content provokes a behavior. What is the change you want to spark in your audience? What are your learning objectives?**

Effective educational videos make their audiences do something, and it’s usually something very specific. A video that “raises awareness” works better when the actual goal is to get audiences to do something more specific, like sign up for a new class as a result of watching the video, vote a particular way, or share the video. Like with target audiences, I recommend being as specific as possible and honing in on one or two target behaviors. Other behaviors may emerge as a by-product, but it’s very difficult to start with multiple, broad, target outcomes and expect that any will happen at meaningful depth. Most of the following strategies are relevant regardless of your target behavior and are merely starting points for framing your production, not guaranteed solutions.

Do you want your audience to:

- Be able to display comprehensive working knowledge of your content so they can apply this new knowledge to a problem or exam question?
  - Encourage active retrieval by having viewers make predictions and apply concepts themselves to questions you pose throughout the video (Karpicke 2012, Muller 2008).

- Have greater content literacy to apply in their everyday life (i.e. voting, having a greater appreciation for the world around them, etc.)?
  - Appealing to particular emotions like surprise and inspiration will be particularly important in your production approach (Guerini and Staiano 2015, Welbourne and Grant 2015, Koumi 2006), as will executing curiosity-sparking elements and addressing misconceptions.
  - There’s an interesting body of research around communicating controversial, science-related voter issues like climate change, vaccines, and nuclear power. This research emphasizes the importance of presenting scientific information in a way that’s in line with viewer’s values and presenting information from a diverse set of experts instead of simply inundating audiences with facts (Kahan 2010).

- Share the video with their friends?
  - Appealing to particular emotions like surprise and inspiration will be particularly important in your production approach (Guerini and Staiano 2015) by making the familiar unfamiliar (Choe 2015).

- Pursue a career or project in a particular domain?
  - Have a holistic understanding the roadblocks that prevent this behavior in the first place. Learning sciences research has shown that role models can impact young student learning, particularly ones to whom students identify similarities (Gehlbach et al. 2015), and can impact career pursuits (Beaman et al. 2012, Campbell and Wollbrecht 2006). The ability for video to scale personalities can be particularly powerful considering a study that suggested that showcasing science, technology, engineering, and math (STEM) professionals in videos might pique interest in STEM careers in middle school students. However, the evaluation method in this study neglected to consider the quality of and effect sizes were too small to be conclusive (Wyss et al. 2012). Additionally, a 2013 study showed that simply showing female role models was much less effective in piquing physics career interests compared to talking about the issue of underrepresentation of women in physics classes head-on (Hazari et al. 2013). Using video as an opportunity to showcase strategic role models to audiences otherwise unexposed to these individuals could encourage underrepresented minorities to self-identify and build self-agency in these fields, but it has to be done knowing that issues extend far beyond visibility of underrepresented role models.
**CASE STUDY: Audience Behavior**

**How Braces Work (MITK12Videos) [https://youtu.be/6zzA4BU2e58](https://youtu.be/6zzA4BU2e58)**

**Target audience:** Middle-high school students who are active on YouTube, willing to watch educational channels (like SciShow, Vsauce, Veritasium, etc.) and who have had or are getting braces.

**Target behavior:** Our intent wasn’t necessarily to rack up a lot of views with this video, but mostly to trigger attitude shifts in viewers to make them have greater appreciation and awe of the human body (specifically, bone remodeling, and how our body grows), and get audiences to subsequently share the video.

**Observations:** Interestingly, while we did end up getting quite a few teenage female viewers who fall squarely into our target audience, this video also ended up resonating with fans of the Mythbusters Facebook page, who shared the video. Had we tried to appeal to broad audiences, the message may not have resonated as clearly with either one. The important distinction here is that targeting an audience doesn’t necessarily mean alienating another - though the target audience was 13-18 year olds, we made a conscious effort to make the material understandable, not patronizing, which is why it appealed to Mythbusters’ largely 25-40 male audience. In other words, understanding our audience helped guide a clearer production process for us, but because we didn’t talk down to that audience, it appealed to people outside that group, too (Choe 2015).
5. HOW WILL MY VIDEO BE DIFFERENT FROM WHAT’S ALREADY OUT THERE?

There are many ways to tell the same story - how will yours be effective and unique?

There is a lot of redundancy among existing educational videos because there are many ways to deliver the same content. While some of this noise might actually help people discover your video, you’ll want to think about how your production will add something meaningful to the existing digital conversation. Will it be a video that has much better audio and visual quality than what already exists, or will it take a more fundamentally different approach to explaining the content? Will it be a video that’s tailored to a different audience? Are you offering a perspective or expertise that’s unique?

Pulling it off: Ask yourself, “What expertise do I have to offer and who else should be on my team?”

Project management, creative vision and execution, production expertise and technical know-how, content/domain expertise, community engagement, instructional design - very few people can do it all. Koumi and Mayer both write about this, and in my experience, communicating technical topics is about leveraging your own competencies, understanding your limitations, and winning where you can.

Other questions to ask are: what do I really have to offer, and what capacity (or resources) do I have to execute my project at the quality that I want? Are there any restrictions that I have? Is the payoff worth the resources I’ll need to invest? Remember that video production costs time and/or money. For many organizations, a host-driven format like Smarter Every Day or The Brain Scoop aren’t realistic if the host doesn’t have the time or capacity to engage with the audience on the channel or isn’t strong enough in their hosting abilities. For others, that format might be just the right thing. Once you figure out what you’re working with, you can move onto thinking about how you’ll make your video.

All of the following videos on the gut microbiome essentially tell the exact same story (the same “X” AND the same “Y”) - we are more microbe than we are human. They emphasize just how redundant online educational videos can get. They’re all executed to varying degrees of success, but they’re all optimized for their own particular audiences, which may be enough to justify why they were produced.

CASE STUDIES: Make It Unique

You Are Mainly Microbe… Meet Your Microbiome! (It’s Okay To Be Smart)
https://youtu.be/4BZME8H7-KU

Good: The opening sentence is another take on making the familiar unfamiliar: “No matter how much we steam, sterilize, or scrub ourselves, we’re still outnumbered by our inner ecosystem...you and I and everyone on earth is mainly microbe.”

Room to Improve: The presenter’s body language and tone of voice is sometimes a bit awkward. The visuals don’t do a lot to clarify content and are a little gimmicky. And while the point of the video - that the microbes inside of us are good and vital - is strong, the video occasionally feels like a random string of pub trivia factoids.

The Invisible Universe Of The Human Microbiome (NPR)
https://youtu.be/5DTrENDWvWM

Good: The premise of this video is the same as the first - there are a LOT of microbes in the human body and they’re surprisingly important.

Room to Improve: This video was posted on YouTube 8 months after case 1, though it’s almost identical in content to case 1. The primary difference is that this video takes a more visually artistic interpretation, animated by artist Ben Arthur. I’m not sure that the artistic quality is enough to merit this video’s production, especially since the visuals don’t add anything to enhance my
understanding of the content. There’s a bit of a tone mismatch between the playful, childlike visuals and the stereotypical news/podcast narration. It’s also a bit unclear why NPR produced this in the first place, since it doesn’t seem essential to their news stories. It’s possible that the motivation to create this was more internal; it was an opportunity for NPR to experiment with this kind of production as a useful exercise for them.

The human microbiome and what we do to it (NPS MedicineWise)  
https://youtu.be/EEZSuwks7Ik

Good: The premise of this video is the same as the first two - there are more microbes in us than human cells, and we need these microbes to survive. It highlights a person of interest - an actual professor of microbiology and medicine.

Room to Improve: The visual style (framing, zooming in on interviewees, music, etc.) is extremely dated. The animations of the cells and other b-roll footage don’t really relate to what the speakers are saying and the expert speaker’s narration is awkward and hard to follow - snappier editing would have made his lines more cohesive.

Hungry Microbiome: Gut Microbiota (CSIRO)  
https://youtu.be/F4zTyZRdRpY

Good: Like the first three videos, this video starts with the fact that humans have a LOT of microbes, and those microbes are vital to us.

Room to Improve: The whiteboard-style drawings are often gimmicky and distracting. In many instances, the drawer’s hand is completely blocking the illustration, or the narration has nothing to do with what’s being drawn. It’s also poorly edited - at one point, two different audio tracks are playing at the same time, overlapping each other.

Our Microbiome - Health Matters (University of California Television)  
https://youtu.be/yfh6j_HF8NQ

Good: Once again, this video opens with the notion that our bodies are outnumbered by microbes that are very important to us. It features a person of interest - a microbiome researcher - interviewed in a talk show style by a medical doctor.

Room to Improve: The visual aesthetic - the background, how it’s shot, framed, lighted, etc. - is extremely dated and the jarringly neon and arbitrary background is distracting. The talk show format is a gamble, since it relies so heavily on the subjects being engaging and interesting to watch. Unfortunately, both subjects aren’t either one of those things. The content itself is quite fascinating and might have been spoken (or at least edited) more concisely and effectively in a more controlled environment (perhaps doing an interview/animation combination like Fig. 1, having an interviewer in the lab with the researcher, or making this a podcast).
6. HOW WILL I MAKE MY VIDEO?

How you make multimedia is just as crucial as what you make in influencing how someone learns from it (Baird and Fisher 2005).

There is no inherently superior multimedia format and there is no inherently superior video format, but there are some general guiding principles for best executing the technical elements of production:

- Know the basics of video production. Like good lighting and sound are non-negotiable. Be aware of the different production approaches and styles that you can use.
- Use the basics of multimedia storytelling. Integrate elements like signposts, audience engagement, and misconceptions to help your audience learn.
- Let a tastemaker guide good design choices to establish a particular tone and vibe for your video. Collaborate with experienced practitioners and producers.
- Budget time and/or money and expect a non-linear, iterative, team-based process. Video production is resource intensive!

Know the basics of video production:

Even if you’re not an expert in video production, some digital media fluency will help you identify teammates and evaluate products more critically.

- How to Shoot Video That Doesn’t Suck by Steve Stockman is a good starting point for learning how to capture good audio and lighting, which are fairly uncompromisable in video (Hansch et al. 2015).
- Video Formats: An Inspirational Guide by Mark van Huystee is quick overview of various video format styles (talking head interview, on-location, screen capture, etc.) and how you can use them.

An appendix of The Role of Video in Online Learning: Findings from the Field and Critical Reflections by Hansch et al. 2015 includes a typology of video production styles that also provides a useful menu of video format options.

- Vimeo’s Film School (https://vimeo.com/blog/category/video-school) has free videos covering everything from equipment to gathering your crew, along with short assignments to practice your skills.
- Websites like lynda.com and skillshare.com offer online courses on various editing software and production techniques.

The following media illustrate the same concept - centripetal force - using very different production approaches. They show how much the execution of the production can impact a learner’s experience.
CASE STUDIES: Production Approaches

Centripetal Force: Roller Coaster Loops (WGBH)
Production Approach: Live/on-location
Good: By incorporating diagram overlays onto live footage of roller coasters, this video helps contextualize the concept of centripetal force through a concrete and relatable example and makes it more intuitive to learners.
Room to Improve: The video takes a long time to get to the point, which might lose viewers' interest. The narration is very formal/after-school-special and rattles off terminology in a traditional, textbook-like way. The aesthetic is also very dated.

Centripetal force and acceleration intuition (Khan Academy)
https://youtu.be/vZOk8NnjLq
Production Approach: Tablet lecture capture
Good: Sal Khan’s natural delivery and tablet usage are clear and slow enough to make the mathematical components of centripetal motion understandable. He also engages with the audience by asking them to make predictions. This is effective for its target audience (usually students who need this information to pass an exam).
Room to Improve: This video is designed for already content-inclined students; screen capture really only minimally transforms the classic chalkboard experience online, and it’s mainly useful to show how to solve exam problems. It lacks the curiosity-sparking element and is HIGHLY dependent on the skill of Sal Khan’s narration and comfort with tablet-style lecturing. Swapping in a different instructor could easily lead to a very boring or very confusing video.

Centripetal Force (PBS Learning Media) https://vimeo.com/94020999
Production Approach: Animation
Good: This simple animation is a concise explanation of the components of circular motion. It contextualizes these components by visualizing them onto an object moving circularly. The narration is also very natural.
Room to Improve: While concise, this video may breeze through concepts a little too quickly - it could take opportunities to engage with the audience more or give learners time to process concepts or try applying them. This could be as simple as saying something like, “if you cut the string you’re using to whirl a ball around in a circle, what would happen? It’d fly off, and that’s because it has tangential velocity” instead of “the ball has a tangential velocity, so if you suddenly cut the string, it would fly off.”

Centripetal Force - The Real Force (ReagentsPrep.org)
http://www.regentsprep.org/regents/physics/phys06/bcentrif/default.htm
Production Approach: Webpage with gifs and print
Good: The short, animated gifs illustrate certain components of circular motion and allow students to process information at their own pace, alongside the text. This is in line with what Koumi summarizes as the “surveyability, navigability, and legibility affordance” of non-video media - it allows students to study the details of centripetal force at their own pace and process an organized set of information.
Room to Improve: The design and aesthetics of this page are extremely dated, with poor navigability and legibility. This text and gif-based explanation of centripetal force could potentially be much clearer than a video with better aesthetics.
Use the basics of multimedia storytelling:

In Jacki Koumi’s paper, “Learning outcomes afforded by self-assessed, segmented video-print combinations,” he recommends the following framework of design principles for videos:

1. Hook (a. capture attention, b. sustain interest)
   a) Shock, surprise, appetite, delight
   b) Create suspense, entertain, fascinate/captivate
2. Signpost
   a) Distant signpost: what’s coming later
   b) Chapter heading: what’s next?
   c) Focus: what to look out for next
   d) Educational rationale: why are we doing it?
3. Facilitate cognitive engagement
   a) Pose questions
   b) Encourage prediction
   c) Establish relevance to personal life
4. Enable construction of knowledge
   a) Words not duplicating images
   b) Pause commentary for contemplation
5. Sensitise
   a) Consistent style
   b) Personalise the teacher
6. Elucidate
   a) Vary tempo to indicate syntax
   b) Restrain image-word density
   c) Alleviate cognitive complexity
   d) Enhance legibility / audibility
7. Reinforce
   a) Repetition (with a different angle)
   b) Re-exemplify
   c) Compare / contrast
   d) Synergy between words and images
8. Conclude / Consolidate
   a) Chapter ending
   b) Summarise key features
   c) Integrate complementary materials

* This framework distills concepts of making the familiar unfamiliar, incorporating interactivity, and Mayer’s personalization principles. Remember to proceed with caution with visual metaphors (see “CRISPR Cas9 And The Mind-Blowing Future of Medicine” on p. 12).

Let a tastemaker guide good design choices to establish a particular tone and vibe for your video:

Media comparison studies in academic journals “suffer from a fundamental problem: how well were the media designed?” From the academic side of things, we often study or care about how effective a video is without considering if the video was, basically, well made (Koumi 2015). And by well-made, I mean if the elements of good media (appropriate lighting, camera movements, close up shots, hosting, music, etc.) have been combined and executed in an effective, appropriate, and thoughtful way.

Technical proficiency and content expertise are integral to video production, but so is taste. Good elements can come together to form something that isn’t very good - a tastemaker can guide the aesthetic and production choices to help the video best achieve your objectives. For the same reasons why it’s difficult to expect students to churn out amazing educational videos after just taking a class, it’s unfair to assume that someone with content expertise or technical expertise can automatically fill this role, too. Even experts on digital media literacy aren’t always the best digital media producers (see https://youtu.be/AKUOxwyWMU as an example). Find a producer who has a good eye, or a coach, mentor, or consultant who will help set reasonable expectations and guide your team by providing taste and self-awareness, who not only understands principles of educational multimedia design, but can successfully execute them using your unique set of...
assets. This is where collaborations with experienced practitioners are most useful.

Watch lots of videos - notice what resonates with audiences and take stock of things that resonate with you. Stay up-to-date with what the communities are doing and trying. And budget time or money to make sure good design and taste are integrated into your production (it usually takes more than people expect).

**CASE STUDIES: Taste**

**The Agony of Opioid Withdrawal (STAT)**
https://www.statnews.com/2016/05/25/opioid-addiction-withdrawal-survival/

**Good:** This video, produced by STAT, a health and medicine online news publication, works because the music, aesthetics, all seem genuine (particularly the hosting) instead of after-school-special cheesy. The lighting, colors, music all match the serious tone without feeling overly dramatic. The animations are clean and easy to understand. Though narration and animation work better together than text and animation (Mayer 2009), text works better than a cheesy voice-of-God narrator in this video to fill in the scientific gaps that the interviewee leaves out.

**Room to Improve:** The illustration is beautiful, but as an animation, doesn't add any meaningful content or explanation. The hosting is conversational, but needs to be edited to be much more concise. The host spends a lot of time explaining something that the illustration, as a still infographic, could have done on its own.

**LIGO Detects Gravitational Waves (Massachusetts Institute of Technology)**
https://youtu.be/B4XzLDM3Py8

**Good:** As a news piece, this showcases people of interest - the researchers who worked on the project that detected gravitational waves. The production value is high (i.e. the videography and editing is technically sound and professional).

**Room to Improve:** Though this video has high quality technical production, the aesthetics and execution are dated (especially music and fonts, pacing, framing, and style of b-roll).

Based on the way the interview clips were spliced together, I still didn’t really understand what LIGO was by the end of the video, aside from something really important that involved a lot of money, lasers, and mirrors.

**Can We Live in a World Without Microbes? (MicrobeWorld)**
https://youtu.be/sax0laedl-Y

**Context:** This video is part of a YouTube webseries produced by the American Society for Microbiology for a general audience.

**Room to Improve:** Several good elements are present in this video - making the familiar unfamiliar (microbes aren’t as bad as assume them to be), contextualizing concepts in the real world, and hypothetical questions to spark curiosity. But a lack of taste means they were executed poorly - the main issue is the inauthentic script that uses formal and technical language inconsistent with the informal format and style of the video. Distracting, amateur, and gimmicky graphics and sound effects rarely provide audio/visual complementarity and don’t clarify concepts. Poorly-executed humor distracts from the content. The familiar concept - that microbes are bad - isn’t fully developed enough.
Beetles, Mites, Cockroaches, Oh My! (The Brain Scoop)
https://youtu.be/rgUP3x8_smY

Context: Emily Graslie hosts this series from The Field Museum, a natural history museum in Chicago, featuring the exhibits and scientists of the museum.

Good: The Brain Scoop follows a very simple and frequently used format - a host who features people of interest united by some common theme. It works well because it’s executed well - Emily Graslie is a naturally engaging host, her interviewees are also good on camera, and the Field Museum has visually fascinating pieces. They feature content and places that are interesting to “visit” through video, giving audiences behind-the-scenes glimpses into a major natural history museum. It’s concisely edited and uses a modern aesthetic in its color grading and typography. All of these elements come together to make a good video - but the content and format don’t universally work.

Budget time and/or money and expect a non-linear, iterative, team-based process:

The elements of production - content ideation, writing, hosting, format, filming, editing, community engagement, distribution, aesthetic - do not happen in isolation. Your chosen aesthetic will affect the way you write, for instance. Think about your team and assets from the very beginning and how those elements will come together to create a video that adds something of value to what’s already out there.

Videos take resources to make and you should accordingly budget time or money depending on the aesthetic and approach you choose. Here are some publicly available information and stats from interviews I’ve done with content creators:

- I produce Science Out Loud (https://www.youtube.com/watch?v=O5wYIfgJ58&list=PLzMsCqGk1hooflK5ifwy6qRXZs7NG6a) with 4 other crew members, in addition to student hosts, and it’s roughly a 5 month process to produce a single season of about 6 videos.
- Nat and Lo (https://www.youtube.com/channel/UCf4AIjSwE-E2TggCPdm-z-A) work on their series full time with about 8 additional staff (videographers, editors, animators, etc.) working for the roughly 2 months it takes to produce one episode.
- Smarter Every Day’s (https://www.youtube.com/user/destinws2) Destin Sandlin spends approximately 100 hours to produce a single video, and he sometimes works with separate graphic artists and production staff https://www.patreon.com/smartereveryday?ty=h.
- Fig. 1 by University of California (https://www.youtube.com/user/fig1) has 2 full-time staff with animation expertise who spend roughly 2 months to produce a single episode.
7. HOW WILL I STUDY/ASSESS MY VIDEO’S SUCCESS?

Instead of honing in on one or two features (like views or length of video), approach and study video using frameworks of thinking to see if people learned from your video, not just if they watched it.

Assessing educational video is difficult because it relies on defining what meaningful learning is and how it looks. As a result, there’s a tendency to measure the “success” of an educational video by asking “Did people watch this video?” rather than, “Did people learn from this video?” While there is clearly merit to understanding what kinds of videos people are more likely to watch, it is problematic to conflate engagement with learning (Hansch et al. 2015). Justin Reich has expressed a similar sentiment: “We have terabytes of data about what students clicked and very little understanding of what changed in their heads” (Reich 2015). Commonly used metrics of success for online videos are often numeric - number of views, shares, and/or subscriptions (Burgess and Green 2009, Welbourne and Grant 2015, Hibbert 2014). But not only do these paint a limited picture, these metrics are largely confounded and influenced by factors such as YouTube’s video recommendation algorithm that promotes rich-get-richer popularity scenarios (Welbourne and Grant 2015, Figueiredo et al. 2014, Zhou et al. 2010).

Additionally, by assessing educational video efficacy in this way, there’s a tendency to map “success” back to plastic factors like the quality of the camera used, the video length, the style of the video (on-set vs. screencapture vs. talking head, for instance), if it puts concepts in real-world contexts, etc. While these elements can contribute to an effective video, they’re only as good as how well they’re executed and if they’ve been used in the appropriate context. Some literature suggests that certain elements like humor, speed of talking, and certain personality styles (Nelson 2011, Guo et al. 2014) should be universally adopted for educational media. However, these are highly contingent on the skill of the talent or producer. For example, Khan Academy arguably works because of the persona of Sal Khan, not because of the tablet format (Hansch et al. 2015). The Smarter Every Day format is not inherently better than a tablet lecture; it would not work for everyone and every circumstance.

Approach and study video using frameworks of thinking, rather than with feature-driven practices. These are not comprehensive strategies for video assessment, nor are they always feasible or the most straightforward to implement, but at least consider them before you start rolling any cameras.

Consider data points in a constellation of evaluations to see how people are watching.

Compare outcomes to intent.

Try more robust ways of assessing learning (think aloud, AEIOU, Science Curiosity Scale, etc.) instead of self-reported surveys.

Look at comment types, not just number of comments.

Collaborate with cognitive sciences to get a better picture of how learning is happening.
Consider data points in a constellation of evaluations to see how people are watching:

Research on videos in MOOCs use data like viewer retention, views, and test attempts as proxies for visible learning (Guo et al. 2014, Hansch et al. 2015, Seaton et al. 2014a), and they’re mapped to a sliver to video attributes (video length, speed of speech, and basic video styles). These limited assessments lead to lack of consensus on video best practices. Research centered on both YouTube and MOOC videos claim shorter video length is better for capturing audience attention as defined by percentage viewed (Guo et al. 2014), yet this is disputed by Welbourne and Grant, who recommend that further research on video length is needed (2015) due to a lack of agreement on what “shorter” really means.

Instead of looking at a small set of numerical data, consider as many analytics tools that are available to you and evaluate digital data in non-digital contexts to see how people are watching, not just if they are watching. YouTube’s analytics include: watch time, audience retention, demographics of users, playback locations, traffic sources, devices where videos are played, added/removed subscriptions, likes and dislikes, videos added to/removed from playlists, comments, shares, and percentage of clicks on annotations and cards, and you can track how these metrics change over time. While views, shares, and audience retention are relevant, traffic sources and playlists may give some additional insight into how people are watching. Understanding views in the context of where viewers were coming from, or if people were planning on watching the video later by adding it to a “Watch Later” playlist helped us gain a broader understanding of how viewers were making sense of our content for “How Braces Work” (Choe 2015).

Giannokos et al. built a video platform that allows instructors to see what parts of a video students replay and how frequently they do so (Giannokos et al. 2015). They found that students were replaying parts of the video that contained information directly related to what would be on a following assessment, or showed the instructor explaining how to solve a problem similar to one that would be on an assessment. They used these video replays to gauge how appropriately difficult the assessment questions were, concluding that things that require a few replays are good, since it means the questions are appropriately challenging the viewers (Giannokos et al. 2015). I’d be careful about jumping to that conclusion - again, there are lots of confounding variables, like the actual quality of the video or instruction - but I think this is a great example of how analyzing how people interact with videos can inform greater teaching practices.

Looking at user access to a video (where and when they play, pause, reload) and evaluating that data in the context of other user characteristics (what country they came from, if they finished the course or not, whether they had an intent to finish the course, etc.) is an approach Seaton et al. took when assessing a MOOC offering in 2014 (Seaton et al. 2014b).

Asensio and Young created a “Three I’s Framework” for assessing videos in education: look at the actual images of the videos, how users can interact with it, and how it integrates into spaces of learning outside the video (social network, classroom teaching in blending learning, etc.) (Asensio and Young 2002).

Compare outcomes to intent:

Did your video do what you originally wanted it to do? If the point of your video is to build skills among viewers, you can test its efficacy by having viewers try those skills out after watching the video (Forbes et al. 2016). Certain metrics may be more relevant to certain intentions than others. Commercial intentions will prioritize shares as the ultimate goal (even more so than views); broader intentions like sparking curiosity will rely on qualitative metrics listed in the following sections.

Justin Reich recommends also mapping outcomes to viewer intent, not just producer intent - understanding why people watched the video in the first place (were they just browsing on YouTube, did their teacher assign it to them, are they looking something up for a personal or professional project, etc.) can help you better gauge how they’re learning with it (Reich 2015). In his study, Reich and his colleagues at HarvardX had users fill out quick survey questions before starting their online class. By understanding why they came to the course, his team could better understand the retention data as the course progressed. Understanding intent paints a much richer picture than the quantitative data does alone. For example, there are several factors that motivate people to share online, many around building a perceived identity (Guerini and Staiano 2015, Rainie et al. 2012, Tan and Pearce 2011). Similarly, what motivates someone to watch a video can be different from what motivates them to share (Hanson and Haridakis, 2008), which is complexly tied to what motivates them to learn.
Try more robust ways of assessing learning (think aloud, AEIOU, Science Curiosity Scale, etc.) instead of self-reported surveys:

Self-reported impacts and surveys from viewers are frequently used to make learning visible (Kaltura 2015, Hibbert 2014, Ilioudi et al. 2013), but they don’t always accurately reflect learning, and there’s a non-negligible level of inaccuracy associated with them (Reich 2015, Muller 2008, Kahan et al. 2016). While they’re often one of the few (or at least, easiest) options to get a qualitative sense of viewer learning, there are more robust evaluation options!

If you have access to your viewers, a think aloud protocol may provide more insights into how they’re making sense of the material. Originally applied to cognitive research, this approach essentially has viewers verbalize their thoughts out loud as they interact with an object, text, and/or task (Ericsson and Simon 1993). As viewers watch a video, you can simply ask, “tell me what you’re thinking as you watch this video,” or you can ask them to reflect out loud after the video is complete (Johnstone et al. 2006). The follow up is useful since having viewers provide real-time feedback can sometimes distract them. Consider recording these freeform thoughts via text notes or video - much like the “react to” videos on YouTube like “Teens React to Student Lecturing Teacher” https://youtu.be/UOvnWIQmicg (caveat: this is definitely not an educational channel, and this example is meant to illustrate format, not content).

Burns, O’Connor, and Stocklmeyer’s AEIOU approach may help you process this think aloud data - they suggest that

- **Significant indicators of learning:** willingness of students to talk about the physics in the video aloud during class
- **Significant indicators of depth of understanding:** breadth of accurate conceptions that students discussed, students forming opinions, and student confidence when they raised physics issues in conversation

(Dan Kahan and researchers at the Cultural Cognition Project at Yale School developed a more psychometrically sound Science Curiosity Scale - a way to evaluate someone’s interest in seeking out science information for fun - to assess how viewers interact with science documentaries. Instead of asking participants to rate agreements to statements like “I am curious about the world in which we live,” or “This video made me more interested in science,” the SCS_1.0 is presented as a marketing survey that asks participants about websites they read for fun, visits to science museums, going to public lectures, etc. to avoid social desirability bias associated with self-report measures (Kahan et al. 2016).

Look at comment types, not just number of comments:

Comment types are a way of making sense of the “instrumental collaborative exchange and curiosity-driven dialogue” (Hibbert et al. 2014) that occurs in learning communities. They illustrate how the participatory communities that are unique to digital video (versus traditional) shape the video experience (Welbourne and Grant 2015).

Gert Kortemeyer developed a categorization system for posts on online homework discussion boards that extends beyond just simply counting the number of comments: emotional, surface, procedural, and conceptual. (Kortemeyer 2006). This was a useful framework for me when I analyzed our “How Braces Work” video, whose comments fell into roughly four categories of increasing cognitive complexity that I called sense of wonder (“Whoa this is so cool”), anecdotal (“Who else is watching cause they just got braces?”), clarification (“Wait how are teeth stronger than bone i thought they were bone”), and inquiry-based (“So do osteoblasts play a role in you getting taller too?”) (Choe 2015).

Qualitative assessments of comments can allow us to compare how people respond to the same video on Khan Academy versus watching it on YouTube at home versus watching it on YouTube in a classroom activity facilitated by a teacher and shed more insight into how the digital contexts of video contribute to curiosity and identity-building. It can also help you process think aloud data.
Collaborate with cognitive sciences to get a better picture of how learning is happening:

Though this approach is definitely the least feasible among most video producers, there’s a lot of potential to apply cognitive sciences approaches to understanding how video facilitates learning.

Mayer used techniques like eye movement detection to determine his principles like spatial contiguity, which says that printed text and related graphics that are close to each other on-screen, not far apart, are better for learning (Johnson and Mayer 2012). Researchers have also used functional magnetic resonance imaging (fMRI) to identify unique networks in the brain that are activated when viewers watch normal video action sequences, but not by sequences of random video shots or by highly scrambled video image sequences (Anderson et al. 2006). Perhaps these research perspectives can be applied to better understanding if videos are meaningfully sparking brain activity and learning.
8. WHAT RELATED WORK HAS ALREADY BEEN DONE?

Don’t reinvent the wheel – there are plenty of resources and research around the field of educational video.

I recommend the following people for further reading and following. This is not necessarily an endorsement of their views (nor is it comprehensive), but their work and very different perspectives are a good foundation for understanding the landscape of this field. Before starting video projects, you might find it helpful to browse these materials, in addition to looking at what videos have already been made.

Voices in video (research and/or production):

- **Richard E. Mayer**, Professor of Psychology at the University of California, Santa Barbara who studies multimedia for learning through a cognitive sciences perspective
  
  - Research-based principles for multimedia learning: A crash course lecture he gave at Harvard Initiative for Learning and Teaching’s Scholar to Practitioner Speaker Series on May 5, 2014
    
    https://youtu.be/AJ3wSf-ccXo
  
  - Multimedia learning (2nd ed), Cambridge University Press 2009

- **Hank Green**, creator and host of SciShow, Crash Course, vlogbrothers, Internet Creators Guild, Subbable (now part of Patreon), VidCon
  
  - “You Can’t Make It On YouTube Anymore,” 2014
    
    https://medium.com/@hankgreen/you-cant-make-it-on-youtube-anymore-10977c194a4f#9ch5f9xvxw

- **Jack Koumi**, consultant for educational media in higher education and teacher training
  
  - “Learning outcomes afforded by self-assessed, segmented video-print combinations,” Cogent Education, Volume 2, Issue 1, 2015:
    
  
  - Multimedia learning (2nd ed), Cambridge University Press 2009

- **Derek Muller**, creator and host of Veritasium
  
  - Designing Effective Multimedia for Physics Education, University of Sydney Australia, 2008:
    
  
  - “This Will Revolutionize Education” (Veritasium)
    
    https://youtu.be/GEmuEWjHr5c

- **Chareen Snelson**, Associate Professor of Educational Technology at Boise State University, who studies YouTube, online video, and massively multiplayer online games (MMOGs).
  
    
    http://jolt.merlot.org/vol7no1/snelson_0311.pdf

- **Daniel R. Anderson**, Professor Emeritus of Psychology at the University of Massachusetts who researches focuses on the cognitive impact of television on children
  
  - “Cortical Activation While Watching Video Montage: An fMRI Study,” Media Psychology, Volume 8, 2006

Video production:

- **How to Shoot Video That Doesn’t Suck: Advice to Make Any Amateur Look Like a Pro**, Steve Stockman, 2011

- **The Viral Video Manifesto**, Stephen Voltz and Fritz Grobe, 2013

- **In the Blink of an Eye**, Walter Murch, 2001

- How We Make MinuteEarth Videos (Behind the Scenes) (MinuteEarth):
  
  https://youtu.be/tlnIzybxCW1k

- SciShow pitch deck:
  
  https://drive.google.com/file/d/0B_NWMzYoHbn3d2hYSIBLY1NCY1E/view

Storytelling practicals:


- **Ira Glass on Storytelling**, part 1 of 4 (PRI Public Radio International)
  
  https://youtu.be/loJ3FtCJJA
Voices in educational media/MOOCs:

- **Tony Bates**, consultant for e-learning and distance education
  - Teaching in a Digital Age, 2015
    https://opentextbc.ca/teachinginadigitalage/
- **Justin Reich**, educational researcher and Executive Director of the Teaching Systems Lab at the Massachusetts Institute of Technology
    http://science.sciencemag.org/content/347/6217/34
- **Sandra Schuck and Matthew Kearney**, Professors of Education at the University of Technology Sydney who have written extensively about student-generated videos for learning
  - “Capturing learning through student-generated digital video,” Australian Educational Computing, Volume 21, Number 1
- “The Role of Video in Online Learning: Findings From the Field and Critical Reflections,” 2015, by Anna Hansch, Lisa Hillers, Christopher Newman and Thomas Schildhauer (Alexander von Humbolt Institute for Internet and Society) and Katherine McConchie and Philipp Schmidt (MIT Media Lab)

Legal, privacy, and internet:

- Teaching Privacy project at Audio and Multimedia group at Berkeley’s International Computer Science Institute
  http://multimedia.isci.berkeley.edu/multimedia-and-privacy/teaching-privacy/
- Youth and Media Project the Berkman Center for Internet and Society at Harvard
  http://youthandmedia.org/ and their Student Privacy Initiative
  https://cyber.law.harvard.edu/research/studentprivacy
- Internet Creator’s Guild
  http://www.internetcreatorsguild.com/

Science communication:

- Cultural Cognition Project at Yale Law School Dan Kahan
  http://www.culturalcognition.net/
- Science of Science Communication at the Annenberg Public Policy Center of the University of Pennsylvania
  http://www.annenbergpublicpolicycenter.org/science-communication/
- Science Communication Research: Bridging Theory and Practice - an annotated bibliography from the American Association for the Advancement of Science, 2016
- Special colloquia from the Proceedings of the National Academy of Sciences on the Science of Science Communication
  - 2013: http://www.pnas.org/content/110/Supplement_3
  - 2014: http://www.pnas.org/content/111/Supplement_4
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A case study-based primer for informal, educational, digital video best practices

Optimizing Video for Learning:


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- Community Management by Milky - Digital innovation from the Noun Project [https://thenounproject.com/search/?q=community+online&i=33100](https://thenounproject.com/search/?q=community+online&i=33100)
- Big Idea by Edward Boatman from the Noun Project [https://thenounproject.com/term/big-idea/13680/](https://thenounproject.com/term/big-idea/13680/)
- Fingerprint by Diego Naive from the Noun Project [https://thenounproject.com/term/fingerprint/120160/](https://thenounproject.com/term/fingerprint/120160/)
- Video Camera by Yorlmar Campos from the Noun Project [https://thenounproject.com/term/video-camera/37492](https://thenounproject.com/term/video-camera/37492)
- Swing by Swat Vatatiyaporn from the Noun Project [https://thenounproject.com/term/swing/86536/](https://thenounproject.com/term/swing/86536)
- Creative Team by Delwar Hossain from the Noun Project [https://thenounproject.com/term/creative-team/781796/](https://thenounproject.com/term/creative-team/781796)
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