Making the most of demonstrations, videos, animations, or simulations in lectures and laboratories

Jane Maxwell and Jared Stang

This 2-pager is based on a workshop offered at the UBC Annual Science Education Open House on April 13, 2015, www.cwsei.ubc.ca/EOYevent.html. Many thanks to all those who participated for sharing their ideas and insights!

Make a prediction: Which of the following resources will lead to the most learning: an animation of a dynamic process (e.g. a heart pumping blood), or a set of static images and descriptions for the same process?[1]

No really – make a prediction before you read any further!

Ready? It turns out that there is no significant difference in the learning gains achieved using animations and static images, so long as the two resources include the same content.[2,3,4] To understand this counter-intuitive result, consider the reasons why students may fail to learn from a demonstration, video, animation, or simulation (referred to from now on as demo/video).

Students may fail to learn from demos/videos if they:[5]

- See demos/videos as entertainment or as a break from lecture rather than as an opportunity to test or expand their understanding
  - If seen as unimportant, students will tune out or switch into passive observer mode
- Lack prior knowledge required to interpret the demo/video
  - Novices may struggle to distinguish signal vs. noise
  - Failure to connect concrete elements of demo/video with symbolic representations used in class and on tests
- Possess *incorrect prior knowledge* that biases their interpretation
  - Students may even misperceive or misremember what happened in the demo/video, in which case the demo/video may increase their confidence in that misconception
- Mistake familiarity with what is happening in the demo/video for true understanding
- Lack opportunities to test their descriptions and explanations

We can summarize the points above by saying that, ***in order to be effective for learning, a student must invest mental effort in using the demo/video to test or further their own understanding.***

In the earlier case of animations vs. static images, the animations may actually require students to invest less mental effort, since students "don't have to mentally envision how the parts are moving."[1]

Acknowledging that not all videos, simulations, animations, and demonstrations are optimized to help students engage in this way, what strategies are available to instructors to overcome the pitfalls and encourage students to invest their mental effort?

Strategies to help students learn from demos/videos:

- Before the demo/video, give clear prompts how students should engage
  - Whenever possible, ask them to make a prediction; this significantly increases the number of students who correctly observe the demo[6]
  - "As you watch this, I want you to focus on/look for…"
  - Have students record a measurement from the demo/video, if appropriate
  - Pause to refocus or provide new prompts as needed

Strategies to help students learn from demos/videos (continued):

- Clearly communicate how the demo/video is important/helpful to learning
  - How does it connect to learning goals?
  - How will engaging with the demo/video help students to succeed on assessments?
- Incorporate contrasting cases to help students to focus on key features
  - In live demos or simulations, compare/contrast at least 2 different conditions so that students observe *trends* or *differences* rather than isolated phenomena
  - For videos and animations that don't include contrasting cases, or if time is short, add a hypothetical contrasting case: "What would happen if we changed…"
- Ask students what they saw, rather than assuming that they all perceived the results in the same way you did
  - "What did you see/notice?"
  - "What were the key features …"
- Incorporate different representations along with videos/demonstrations
  - Consider how students would be asked to represent the information on a test or assignment and incorporate those representations (shorthand notations, equations, vector diagrams, circuit diagrams, graphs, molecular structures, …)
  - Even better, have the students create these representations before checking them against your own!
- Provide students with opportunities to develop and test their explanations
  - Before the demo/video, "Why did you make that prediction?"
  - Once students have observed the demo/video, "What happened and why?"
  - Pause and allow time for students to think individually or write down their explanations
  - Ask students to test their explanations with peers and look for points of disagreement or confusion
- Use clickers or worksheets to add structure, collect feedback, and ensure that instructions are clear and students are participating
  - Consider showing the demo/video in parts, with pauses for students to predict, write an explanation, and/or talk to their neighbour about what they're seeing and thinking
- Leave time for questions and listen carefully

References and resources:

1. Derek Muller, "This will revolutionize education," https://www.youtube.com/watch?v=GEmuEWjHr5c
2. Boucheix, Schneider (2009) Static and animated presentations in learning dynamic mechanical systems. *Learning and Instruction*. 19(2), 112-127
3. Clark (1994) Media will never influence learning. *Educational Technology Research and Development*. 42(2), 21-29
4. Kim et al. (2007) The effect of animation on comprehension and interest. *Journal of Computer Assisted Learning*. 23(3), 260-270
5. Roth, McRobbie, Lucas, Boutonné (1997) Why may students fail to learn from demonstrations? A social practice perspective on learning in Physics. *Journal of Research in Science Teaching*. 34(5), 509-533
6. Miller et al. (2013) Role of physics lecture demonstrations in conceptual learning. *Physical Review Special Topics - Physics Education Research.* 9(2), 020113-1 - 020113-5
7. PhET interactive simulations, https://phet.colorado.edu/en/simulations/category/new
8. Sokoloff, Thornton (2004) *Interactive Lecture Demonstrations, Active Learning in Introductory Physics* (p. 374). Hoboken, NJ; John Wiley & Sons, Inc.