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More movies, please

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Everybody likes watching a movie, video clips are fashionable, new generations are only attracted by visual inputs, but… how to use this media to achieve an educational experience that helps secure knowledge? This is the inspiration for this summertime instalment.

One of the steps every one of us has probably gone through while using resources for teaching was the switch from images to animations. In the simplest variety, it's truly *animated cartoons*, with basic shapes, schematic, but with undeniable value to understand the reality of physical, chemical and biological processes. Since the boom of internet, many of us have hoarded those animated diagrams which allow us to show diverse aspects in our biochemistry lectures. We even prepared collections of animations[1] to have them close at hand as well as to share them. It is true that, more recently, the efficiency of search engines has made this collecting eagerness less essential, since new animations appear all too frequently and all of them may be located with reasonable speed in the net. In contrast, now the problem is nearly of high throughput screening: how to filter so much abundance and select those that are worthy.

Technological means have progressively changed the aesthetics of animations, which is approaching that of modern cinema. I think it relevant to pose a reflection about virtues and disadvantages of each type of animation, video or movie, when used as a teaching resource, sprinkled –as usual here– with suggestions, examples and tools you may take advantage of. May these reflections also help you to choose animations and videos with the most adequate

features for each situation and context of your students.

Formats, styles and virtues

At the lowest sophistication we can find animations with simple shapes, basic and flat colours, and movements directed to their target. Even though these might look as oversimplified, that's precisely their value: they must be clear and transmit a straightforward message: mainly movement and interactions. We should not dismiss them, particularly in early stages of the learning process. As an example, I always like citing a little collection I found time ago, made by a tandem of two Giannini's[2] father professor and artist-programmer son) and which, after obtaining permission, I collected in my website together with translations and some brief explanations.[1]

At an intermediate level of technical development we can found professionally made animations, with a medium impact, among which we might highlight those that accompany classical textbooks, already in their fifth or seventh edition, with abundant and excellent complementary material, formerly in a CD-ROM, now online accessible to everyone.[3] I remember, for instance, the PCR technique, cloning using a plasmid, or the sketches for replication, transcription and translation.

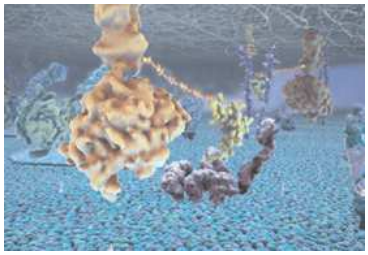

Figure 1. A frame from the video *The Inner Life of the Cell.*[6]

Figure 2. A frame from the video *How Genes are Expressed: Transcription Factors.*[8]

More recently produced animations use lighting and shading effects, three-dimensional shapes and environment, featuring depth (figs. 1 and 2). The items (often molecules, organelles, subcellular structures) have irregular, more realistic, shapes.[4] As a representative example we may mention the popular video *The inner life of the cell*,[5] made by Harvard professors in collaboration with professionals of the software used in movie production. Most relevant is the extra contribution to knowledge given by similitude to real shapes. We must remember that nowadays some tens of thousands of different proteins have been resolved to atomic scale;[6] we can certainly describe and display a protein as something more than a circle, a sphere or an ellipsoid. It is equally important to keep the relative scale of participating items. In these two aspects, a prominent example is the work of David Goodsell,[7] biochemist and illustrator, although he has not authored animations as far as I´m aware of.

«Those who create quality materials want, in addition to sharing them, to get recognition and to protect their work so, instead of *taking them over*, why don't we direct to the original web source?»

Another outstanding feature of these new generation videos, apart from the obvious aesthetic quality, is that they usually provide an extra component in movement: wobbling of molecules. This is highly interesting and worth mentioning to the students, since both traditional drawings and simple animations tend, for technical limitations, to show direct, linear movements. Important concepts to convey are that molecules continuously move, that they are flexible and, finally, that they are not directed towards their target. Such a predetermination or directionality to the target is correct for a first approach, to understand *what* is happening in a biological process, but it is not for understanding *how* oit happens. Fortunately, some animations[8] do include now this non-deterministic component, showing molecules that move more randomly and that not always *hit their target* on the first attempt.

Therefore, a likely appropriate strategy to channel a successful learning would be to combine simple animations with more sophisticated ones, but always explicitly commenting to the students about both the shortcomings of one display and the remarkable aspects that each one illustrates.

Finally, an example from another category: a commercial advertising (a video clip proper), with real images and sung message: The PCR Song.[9] Made by BioRad as a commercial advertisement, it is very attractive and –most importantly– interesting from the educational viewpoint. It is advisable to project it after having explained the

technique, and insist on the students paying attention to the whole message, which is extensive: from the key elements of the technique and the history of its development to its several everyday applications. It may become an extraordinary educational experience: if grabs attention, with no little humour, and we can use it to engage the students and make them fix in their mind the meaning of this technique which has been revolutionary. As the sound may disturb the nearby classroom, I usually project it between classes (it lasts little over two minutes), and it is worth just for the surprise of the students as they enter the room. *Master lecture* in the purest form!

A question of rights

I cannot refrain from including a comment about the issue of intellectual property and copy rights. It is obvious that those who make materials, with the quality many of those mentioned have, wish to share them and have them used, but they also want to gain recognition and protect their work. In the prevailing culture (or, may I say, the lack of it), everything seems to belong to everyone, and often the most elementary rights of the author are not respected. It is striking the number of copies of *The Inner Life of the Cell*, and other similar videos, that swarm in YouTube and other sites, uploaded by diverse persons as if they were their own and, nearly always, without mentioning the source. Some of them are somewhat justified by addition of captions or translation into other language, but that is not the case in many. There is this trend of "look what I found somewhere, how nice" and, rather than linking to the source, I copy it in "my space" to become popular. Then someone else will copy it from me, and so on. To top it all, the quality of the video often deteriorates as a result of the successive resampling. Thinking aloud: if such university, foundation or producer company have made this outstanding video, and have chosen to offer it freely for anyone to watch or show in their classes, what is the problem in directing to the original website? In many cases, these resources are developed thanks to funding received from either public or private agencies, and some times they actually rely on links or visit counters to prove the relevance of their work or to obtain further funding. We will do more harm than good if we host copies in other sites, so diverting visits to the original site. And all this without going now into discussing the legality of such copies. I will just leave a message to stir the conscience: against what some people prefer to think –nearly always because it´s in their interest–, the copyright does not mean I must cite the source when reproducing something, but I must request permission to be able to reproduce it.

«Let´s not give the students just a list of web links, but rather let´s build activities that involve them; the idea is to create something that catalyses learning and builds knowledge»

Table 1: Sections that make up a lesson or activity in TED-Ed

Title	A title for the activity
Let's Begin...	Introductory text, provided by the instructor
Watch	The video
Think	Multiple choice questions or open-ended questions
Dig Deeper	Free-form text provided by the instructor for explanations or deeper discussion
Discuss	Discussion forum, a space where both the instructor and the students may pose questions o propose topics for discussion. Contributions are chained in a thread and are visible to everyone, in the usual style with forums.
...And Finally	Free-form text provided by the instructor for final comments, proposals for further investigation, etc.

TED-Ed, or how to build a learning activity around a short video

TED Conferences is a non-profit organisation devoted to "disseminate ideas", not only in science *(Technology, Entertainment and Design)*. They started by recording lectures and conferences they offer for free in the web.[10] and,

more recently, they have developed this new product called TED-Ed,[11] about which I´d like to talk here since it is an interesting formula addressed at education.

Starting from a short video as the core piece, in TED-Ed you can develop a series of activities for the student (see table 1). In addition to several sections for text and links, a key component is the section where you present questions you have prepared around the video. Another section lets you create a discussion forum where several topics may be initiated, generating an online dialog among students and also with the instructor.

The starting video may be chosen among the TED-Ed collection. On science topics, and particularly on biochemistry and molecular biology, the choice is not wide. However, that is not a problem, since you can build your activity with any video available in YouTube, and the offer there is much broader –more so as you may eventually prepare your own video and upload it to YouTube.

Questions are a central element of the activity. Both multiple-choice and open-ended questions are allowed. The former, with 2 to 5 answer choices, only one correct, are self-assessed. The latter will obviously require a subsequent action by the instructor who, rather than just saying "it´s right" or "it´s wrong", may open a dialog of the kind "this one is your problem, please review that topic and try again". Each question may be attached to a precise time point in the video, so if the student fails the answer she will receive a tip directing her to that point. The number of questions is limited to 15 maximum, but if you need more you can split them between two activities, either repeating or fragmenting the video.

For a more efficient use, a first suggestion: do not design questions that are answered in the video; the aim is not to check it has been visualised and listened to, but to promote understanding and analysis.

Another interesting intervention is to pose questions that seem to have a direct answer but where the video is either confusing or wrong. As an example, in the video *The twisting tale of DNA*[12] it is clearly stated –both in the speech and in the computer graphics– that the human genome has more genes than that in other species mentioned. This is a conceptual problem to be corrected, dictated by an anthropocentric view of the human being as the most complex organism, summit of evolution. One of my questions in my TED-Ed activity was: "The number of genes of a human is, with respect to a worm, a plant or a fly... (a) lower; (b) higher; (c) it cannot be generalised". Most students chose option "b" since that´s what the video shows. Although that majority will quickly answer according to what the video says, when they see the answer is rejected that will induce their critical mind and promote some discussion, either directly on the question or in the forum. This strategy is, in my opinion, very positive. It lets us surreptitiously introduce a lesson. Surprise may make this learning more memorable, retained longer for the future. It helps develop critical thinking in the student and, particularly, undermines blind acceptance of what is heard and seen in the media. It provides a way to initiate a discussion, maybe overcoming the initial reluctance to participate. Many students will feel encouraged: How are you saying this is not correct, if it is what is said in the video that you gave me?

To participate in TED-Ed, the instructor must open an account in the website, which will allow to create lessons or activities and to share them with, at least, his students. Everything is stored in the server: both lessons and the history of activity. Each student must also sign up, so his work is stored and the instructor may do the follow up (ideally with the real name; none of my students who participated last year on my first TED-Ed experience objected this).

Although it could also be done, usually the aim is not so much a formal assessment of the student as a chance for personal study supported by an educational design and by communication, both individual and collective. On the other hand, the instructor gathers information on the difficulties of learning and may hence reorient part of the teaching (another example of the so *called flipped teaching* do you remember the clickers?).

Figure 3. Summary of student activity in a TED-Ed lesson.

As for review of results, the instructor checks in the system the activity of each student: when she watched the video, when she started working on the question, how many of them answered, in how many attempts, when did she finish (Fig. 3). While reviewing each student´s work on multiple-choice questions, you see all answers tried, not just the final choice. This tends to be the correct one, since the system does not prevent multiple attempts; but, again, the aim is not to control, but to provide positive experiences and not to block progression. With this strategy the instructor receives, therefore, feedback on whether the question was hard or easy, and which are the most common conceptual errors. With open-ended questions, once the student has answered the instructor may add some feedback as a personalised comment, maybe orienting and stimulating further attempts (Fig. 4).

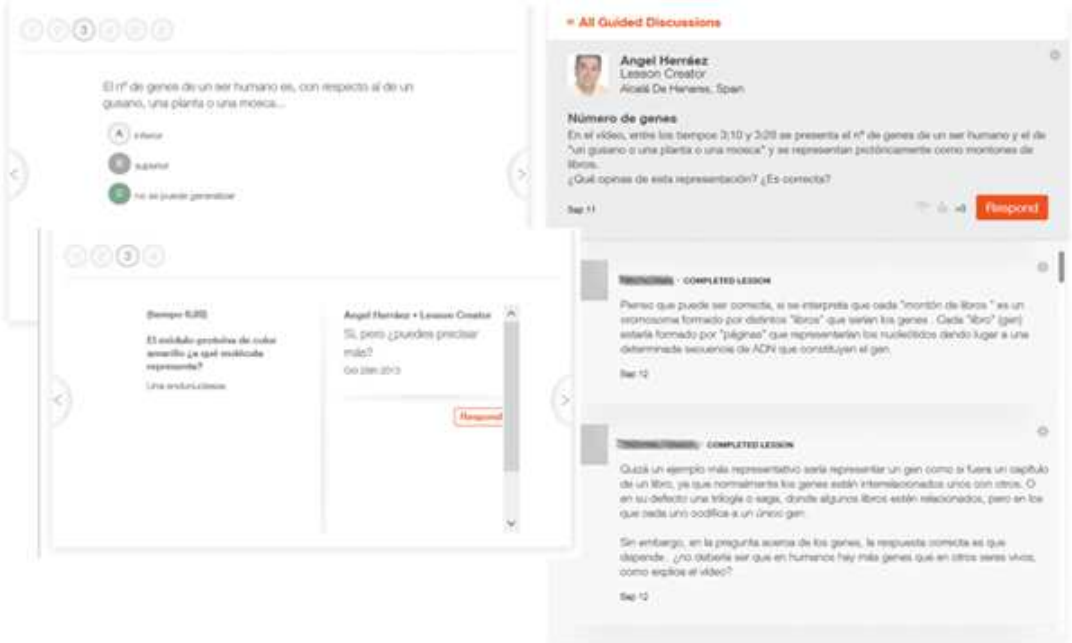

Figure 4. Some sample screens where the activity of students is reviewed.

TED pretends to create communities and so offers an option to share the materials. Lessons in TED-Ed may be *private*, that is, they will not be included in the listing managed by TED-Ed, although anyone that receives the link will see them (note that if you publish the link for your students, that potentially includes internet search engines). They may otherwise be *sheared*, i.e. members of the community will be able to find them and reuse them with their students. Furthermore, you may optionally permit their modification, so other users may create their own derivative lessons.

In summary, I leave you some suggestions and some tools, but my major take-home message would be: Don´t provide students just with a list of webpage links (videos in this case), but instead build activities that involve them, explicitly stating the aims, virtues, limitations, message of each one of them; pose inquisitive questions, so that the video is not just incidental, funny, a break to bring relief within the hours of study, but instead a catalyst of learning and builder of knowledge.

References and notes

1. For instance, in BioROM (http://www.biorom.uma.es/indices/) and in the website of who writes this, Biomodel (http://biomodel.uah.es/biomodel-misc/anim/)-both in Spanish.
2. J. L. Giannini. *Biological Animations.* http://www.stolaf.edu/people/giannini/biologicalanamations.html. Collected as part of the set of animations in Biomodel (ref.1).
3. (a) *Book Companion Site for Biochemistry* by Berg, Tymoczko & Stryer http://bcs.whfreeman.com/berg7e (b) *Book Companion Site for Molecular Cell Biology* by Lodish, Berg et al. *et al* http://bcs.whfreeman.com/lodish7e
4. (a) The Walter & Eliza Hall Institute of Medical Research. *WEHI.TV* http://www.wehi.edu.au/education/wehitv (b) Howard Hughes Medical Institute. *HHMI`s Biointeractive* http://www.hhmi.org/biointeractive (c) Some of the molecular animations from these two sources are also included in the Biomodel collection (ref.1)
5. A. Viel, R. A. Lue, John Liebler. *The Inner Life of the Cell* (BioVisions at Harvard University and XVIVO Scientific Animation). Available at: http://multimedia.mcb.harvard.edu/media.html Narrated copy with captions (SchoolTube, Inc.) at http://bit.ly/op0Epf
6. Among its hundred thousand records, the Protein Data Bank calculates about 30 000 different structures, after discarding sequences with over 50% homology (consulted 14 July 2014).
7. David S. Goodsell. *Molecular Art - Molecular Science* http://mgl.scripps.edu/people/goodsell/
8. Stroma Studios. *How genes are expressed: transcription factors*Available at: http://www.stromastudios.com/portfolio/tfs.html Starting on second 43, the interaction of a transcription factor with its target promoter sequence.
9. Bio-Rad Scientists for a Better PCR. *The PCR Song.* http://www.cnpg.com/video/flatfiles/539/
10. *TED: Ideas worth spreading – and maybe even, ahem, acting on.* http://www.ted.com/
11. *TED-Ed: Lessons worth sharing.*http://ed.ted.com/
12. J. Hauck. *TED-Ed Lesson: The twisting tale of DNA.* http://ed.ted.com/lessons/the-twisting-tale-of-dna-judith-hauck"

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