Using iPads to Make Physics Videos

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ISEP Interdisciplinary Science and Engineering Partnership
SUNY The State University of New York
BUFFALO STATE The State University of New York

Abstract

I am describing the development of Buffalo State's iPad video physics project. Beginning in summer 2015, graduate students and in-service teachers were tasked with explaining concepts or experiments through the creation of short videos labeled physics content multimedia presentations. These have many similarities to videos on the YouTube channels minutephysics and Veritasium, but are not meant to achieve the same production quality. Conceptual learning is the intended outcome of the assignment, not a professional video. Videos are produced on the iPads using filming, editing, and voiceover features of apps like iMovie and iMotion. I am presenting and discussing suggestions, rubrics, guidance, and lessons learned for teachers desiring to assign and evaluate expository physics videos produced by students for credit. This work was supported by the NSF, SUNY IITG and the University of Cologne as well as SUNY Buffalo State Physics.

iPad as a Multimedia Device

The multi-tasking capabilities of the iPad far exceed those of any past multimedia tool. On a single device, students can capture photos and video, use motion-tracking software, edit raw footage, piece together video clips, add sound effects, create voice-over, and produce YouTube style videos. This is made possible by the *iMovie* app that Apple provides on every iPad free of charge. Another free app for multimedia production is *iMotion*, which allows the user to film stop-motion videos. Stop motion has become a staple of YouTube science videos, particularly those created by Henry Reich on his minutephysics YouTube channel.

A screenshot from *iMovie* .

A screenshot from *iMotion*.

Physics Content Multimedia Presentations

By combining the measurement and multimedia capabilities of the iPad, it is possible to produce the types of science videos popularized by minutephysics and Veritasium. These are not slide presentations, lab reports, or compilations of raw experimental footage. Instead, they explain physical phenomena with narration, scripted scenes, experiments, illustration, and animation.

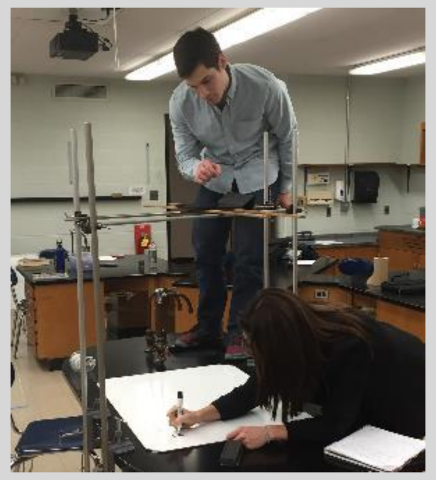
At the University of Cologne, Germany, physics students are assigned group projects in which they use iPads to create multimedia presentations. The purpose of the assignment is not for students to contribute new or improved science videos to the YouTube community. Instead, they are expected to learn about a physical phenomenon through the process of video production.

The assignment promotes a high level of engagement by allowing students to use the familiar technology of handheld devices. More importantly, all students must gain a firm conceptual understanding in order to create an effective video. The project is a much better learning tool than the resulting video, making it an appropriate assignment in college and university settings.

iPads in Graduate Courses

During the months of July and August 2015, Buffalo State held two of its annual summer courses for physics teachers: PHY 510 Physics for High School Teachers: Content & Pedagogy, and PHY 622 Powerful Ideas and Quantitative Modeling: Electricity and Magnetism. For the first time, both courses included a physics video as a group project. Students were provided iPads for use on the project and were given guidance and support by instructors from the University of Cologne.

Two students from PHY 622 are shown working on their physics content media presentations.



Two students from PHY 520 are shown working on an iPad video.

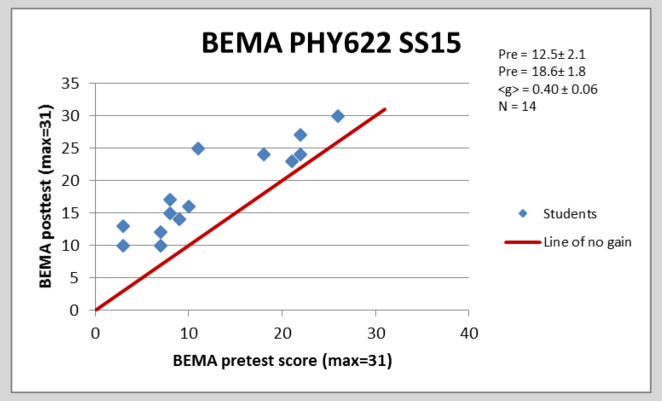
During the Fall 2015 semester at Buffalo State, myself and another student in PHY 520 Modern Physics also completed an iPad physics content media presentation. We created a video as a resource for educators teaching about radioactive decay.

Videos created at Buffalo State are available on Dan MacIsaac's YouTube channel. (Simply search Dan MacIsaac on the homepage of YouTube.)

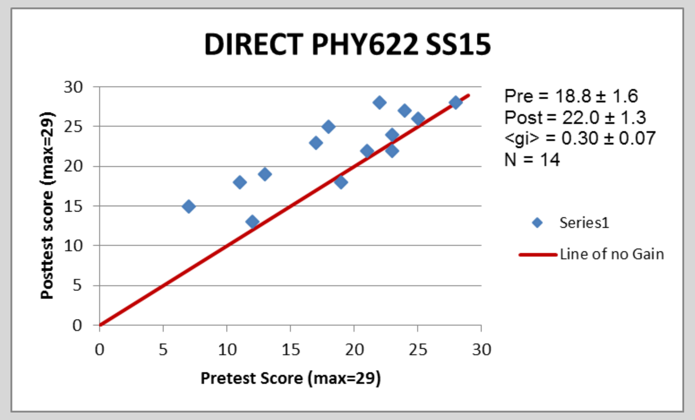
Data

Two assessments are typically used in PHY 622 to measure student learning outcomes: the Brief Electricity and Magnetism Assessment (BEMA) and the Determining and Interpreting Resistive Electric Circuit Concepts Test (DIRECT). Class results from 2015 are in bold.

Test	Course	Instructor (Term)	N	Max	Pre	Post	<gi>
BEMA	**PHY622**	**MacIsaac et al. (SS15)**	**14**	**31**	**12.5 (2.1)**	**22.6 (1.6)**	**0.40 (0.06)**
BEMA	PHY622	MacIsaac et al. (SS13)	17	31	13.4 (1.5)	19.0 (1.0)	0.30 (0.05)
BEMA	PHY622	MacIsaac et al. (SS11)	11	31	14.2 (2.2)	19.2 (2.2)	0.29 (0.09)
BEMA	PHY622	MacIsaac et al. (SS10)	8	31	13.6 (2.8)	19.6 (1.9)	0.35 (0.12)
DIRECT	**PHY622**	**MacIsaac et al. (SS15)**	**14**	**29**	**18.8 (1.6)**	**22.0 (1.3)**	**0.30 (0.07)**
DIRECT	PHY622	MacIsaac et al. (SS13)	17	29	15.8 (1.1)	21.4 (1.1)	0.41 (0.06)
DIRECT	PHY622	MacIsaac et al. (SS11)	11	29	19.2 (1.6)	21.6 (1.6)	0.29 (0.10)
DIRECT	PHY622	MacIsaac et al. (SS10)	8	29	19.8 (1.5)	24.5 (1.4)	0.52 (0.08)



Pre- and Post- assessment scores on BEMA are shown on the left.



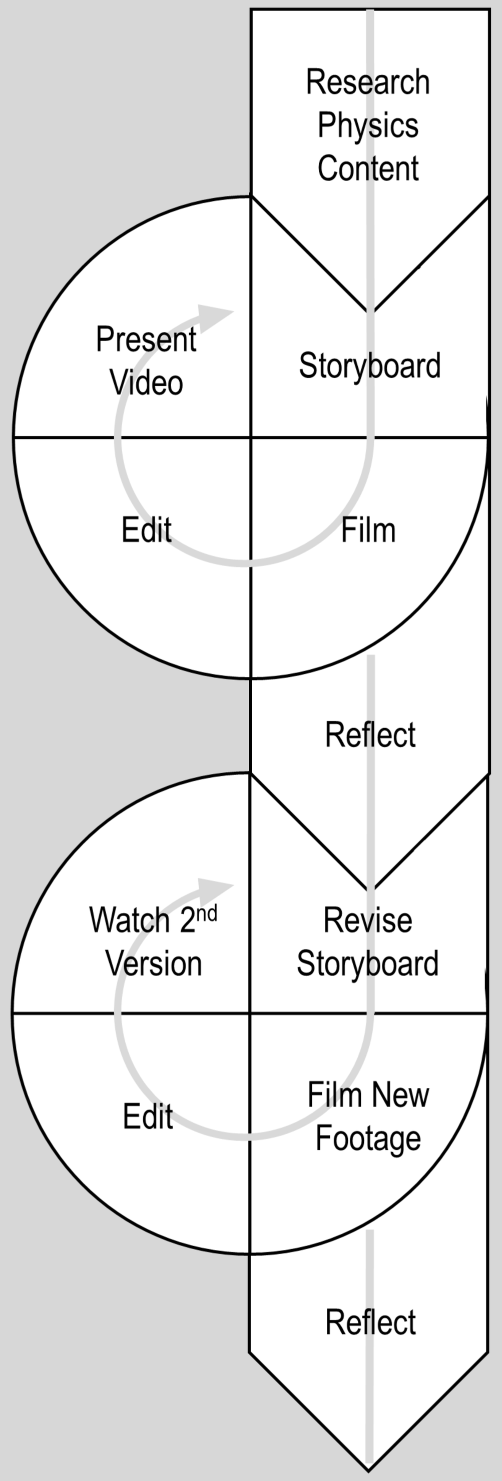
Pre- and Post- assessment scores on DIRECT are shown on the right.

Reflection and Revision

I have personally worked on iPad video projects in both of the summer courses and PHY 520. As part of an independent study this semester, I have been refining the video creation process and identifying realistic goals for its use in physics classrooms.

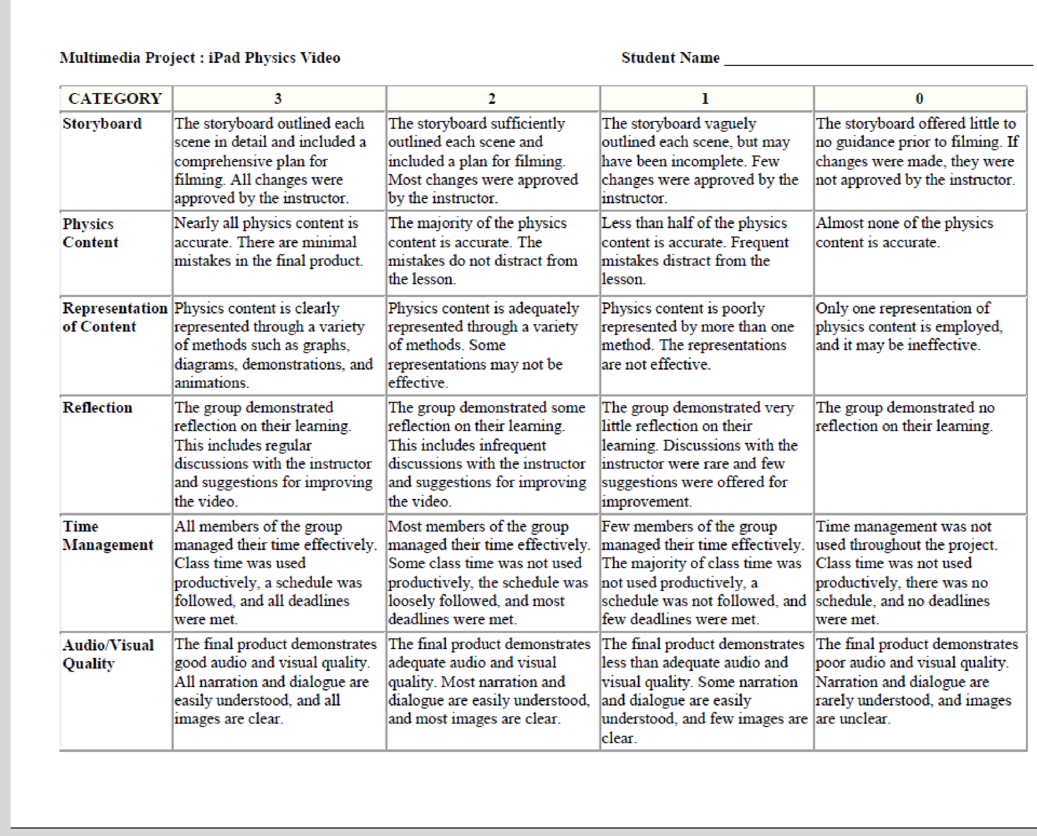
The diagram on the right gives a roadmap for educators who would like to assign physics content multimedia presentations. It should be noted that the first reflection stage is appropriate end to such projects. The initial products will inevitably contain mistakes, but learning and reflecting on physics content is the chief goal. This can achieved in the first cycle.

The second cycle is for those who would like to improve their videos and achieve a YouTube-quality final product. Time restraints prevent this from being feasible in most physics courses. Part of my work this semester has been to produce a second version of the video created in PHY 520. Both versions will be available on Dan MacIsaac's YouTube channel.



Assessment and Rubrics

When assigning a video project in a high school or college physics setting, it is important to keep students focused on learning content rather than perfecting their video. To reflect these goals, a sample rubric is shown below.



Multimedia Project : iPad Physics Video **Student Name** ____________________

CATEGORY	3	2	1	0
Storyboard	The storyboard outlined each scene in detail and included a comprehensive plan for filming. All changes were approved by the instructor.	The storyboard sufficiently outlined each scene and included a plan for filming. Most changes were approved by the instructor.	The storyboard vaguely outlined each scene, but may have been incomplete. Few changes were approved by the instructor.	The storyboard offered little to no guidance prior to filming. If changes were made, they were not approved by the instructor.
Physics Content	Nearly all physics content is accurate. There are minimal mistakes in the final product.	The majority of the physics content is accurate. The mistakes do not distract from the lesson.	Less than half of the physics content is accurate. Frequent mistakes distract from the lesson.	Almost none of the physics content is accurate.
Representation of Content	Physics content is clearly represented through a variety of methods such as graphs, diagrams, demonstrations, and animations.	Physics content is adequately represented through a variety of methods. Some representations may not be effective.	Physics content is poorly represented by more than one method. The representations are not effective.	Only one representation of physics content is employed, and it may be ineffective.
Reflection	The group demonstrated reflection on their learning. This includes regular discussions with the instructor and suggestions for improving the video.	The group demonstrated some reflection on their learning. This includes infrequent discussions with the instructor and suggestions for improving the video.	The group demonstrated very little reflection on their learning. Discussions with the instructor were rare and few suggestions were offered for improvement.	The group demonstrated no reflection on their learning.
Time Management	All members of the group managed their time effectively. Class time was used productively, a schedule was followed, and all deadlines were met.	Most members of the group managed their time effectively. Some class time was not used productively, the schedule was loosely followed, and most deadlines were met.	Few members of the group managed their time effectively. The majority of class time was not used productively, a schedule was not followed, and few deadlines were met.	Time management was not used throughout the project. Class time was not used productively, there was no schedule, and no deadlines were met.
Audio/Visual Quality	The final product demonstrates good audio and visual quality. All narration and dialogue are easily understood, and all images are clear.	The final product demonstrates adequate audio and visual quality. Most narration and dialogue are easily understood, and most images are clear.	The final product demonstrates less than adequate audio and visual quality. Some narration and dialogue are easily understood, and few images are clear.	The final product demonstrates poor audio and visual quality. Narration and dialogue are rarely understood, and images are unclear.

Notice that the emphasis is on ensuring accurate physics content, creating a detailed storyboard, using multiple representations of phenomena, time-management, and reflection on learning.

This rubric was created using Rubistar. It is available at: http://rubistar.4teachers.org/index.php?screen=ShowRubric&rubric_id=2622788&

Discussion & Lessons Learned

Physics Content Multimedia Presentations are a appropriate projects for high school and college physics students, as well as pre-service teachers. However, we caution against using these videos in the place of classroom lessons. Students will not learn nearly as much from their classmates' videos as they will from their own. See Muller's ***YouTube Veritasium*** video "Khan Academy and the Effectiveness of Science Videos" for a cogent discussion of the limits of clear explanation. Our takeaway insight is *"Watching a clear and correct explanation is NOT learning; but creating and refining your own clear and correct presentation fosters learning."*

Making quality videos is hard work, and almost certainly an inappropriate goal for physics content courses for students who are becoming physics teachers. However, the fun, professionalism and attention to detail required of making quality physics videos – especially a final draft video with accompanying notes for improvement does seem appropriate for future physics teachers. While making a video, future physics teachers learn simple video planning, shooting, editing and voiceover skills that call upon their abilities to research physics content and prepare a clear, concise and appropriate presentation order, visualizations, footage, language and mathematics. This serious, enlightening and intense attention to detail and deliberate refined practice is similar to Japanese lesson study and not at all typical of North American STEM teacher preparation. As part of the process future teachers improve their own subject matter knowledge and refine rigorous articulate language, clarity of thought and representation skills they can call upon to guide student discourse in their own classrooms. The participant's physics videos (while highly motivational) are almost an afterthought to the process, and *we strongly believe that attempting to follow through to produce a professional grade video is best left to a follow up project, independent study or capstone project.*

Our Advice: Have students start as early as possible with multiple researched topic explanations (including critiques of other literature and videos), a storyboard and checked mathematics. Students have not generally been exposed to professional-level outcome expectations and usually strive to produce a last minute highly imperfect school-level draft outcome that most classroom instructors accept. *For a physics course final product, we suggest you plan on a solid draft video with extensive guidelines for improvement as an acceptable outcome. Expect much student humor, creativity and lots of "inside jokes" along the way.*

References & Links

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