Online Videos of Physics Demonstrations: A Resource for Tertiary Educators

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Abstract: In Barbados, a small island nation located in the West Indies, there is a shortage of university graduates in the physical sciences, particularly in physics. The result is a limited number of graduates entering the professional fields related to physics. Research has shown that scientific phenomena are often difficult to comprehend without some visual aid. Obtaining access to visuals such as simulation games, DVD recordings, or audio/visual tapes via postal services are complicated by import fees, international exchange regulations, and the length of transportation time it takes to receive goods. Utilizing videos that are readily accessible over the Internet is one way to circumvent these problems.

This study examined websites that provided demonstrations of physics experimentation and animated simulations. These free websites offered tertiary level students online videos over the World Wide Web in all branches of physics. The purpose of the study was twofold: a) to establish a list of quality physics videos or simulations that can be accessed via the Internet; and b) to save lecturers time. The results of this study will be valuable to Barbadian and Caribbean educators, as well as those teaching in inaccessible locations throughout the world.
Keywords: electronic books, demonstration, physics, simulation, video

Introduction

Barbados has a dearth of students enrolled in the sciences at the tertiary level which results in a shortage of graduates entering employment in the scientific fields. At the University of the West Indies (UWI) Cave Hill Campus, 661 graduates were awarded degrees in one of the sciences, over a period of five years. Only 16 of these 661 graduates completed physics-combined majors. Usually students elect to study a combination of either physics and mathematics; physics and computer science; or physics and electronics. Few chose physics alone; only three from the years 2001 to 2005 (UWI, 2006).

The shortage of students does not pertain exclusively to the West Indies. Barton (2002) of the Policy Information Center of the Educational Testing Service in North America reported that enrollment decreased in the physical sciences over the five year period, 1992-1997. Physics enrollment declined by 19 percent (p 7), the largest percentage decrease in the physical sciences. Although there are varied reasons for the shortage, this paper addresses the crisis in terms of accessing and using videos to facilitate teaching and learning.

Background

Value of Visuals in Physics Instruction. Physics principles are the underlying driving forces for all that we do in our everyday life both 'seen and unseen' (Levin, 2002). Yet, to many students, this branch of science is indecipherable and mystifying. Videos offer visuals that are active and dynamic moving events which facilitates comprehension (Norton and Wilburg, 2003). They can be created to manipulate time, lapse time, or expand time (Smaldino, Molenda, Heinrich, and Russell 2004). Besides offering powerful illustrations to

promote the learning process, videos minimize the danger (Smaldino et al) which might be posed if some physics experiments were actually demonstrated in classrooms.

Energy flows are made visible through animation which were highlighted by Belcher and Olbert (2003) who argued that, "animation greatly enhances the student's ability to perceive [the] connection between shape and dynamical effects." Physics concepts are abstract and do not provide points of reference that are associated with real-life situations (Belcher, 2006); therefore, there is a need to offer students visual aids that supplement in-class experiments and offer insight into the unseen phenomena. Physics Education Research (PER), an organization that focuses on physics research and ways to improve instruction, supports the development of new instructional practices (Henderson, Stelzer, Hsu and Meredith (2005).

Researchers have shown that scientific phenomena are often difficult to comprehend without some visual aid to demonstrate theoretical concepts (Squire, Barnett, Grant, & Higginbotham, 2004). Belcher as well as Squire et al, (2004) pointed out that a deeper understanding of physics concepts cannot be obtained purely through mathematical computations. Dori and Belcher (2005) found that visual demonstrations of phenomena contributed to students understanding of physics concepts.

Ten years prior to the SuperCharged (Squire et al, 2004) research, which took place in an urban Massachusetts school, the author of this paper had used visuals as well as in-class physics demonstrations at a California urban school. Although, integrating instruction with visuals increased student learning outcomes, the time involved in finding relevant visuals was extensive. Access to the web was not available. During that time visuals were ordered through on-site library services or through a consortium. Therefore, awareness of the increase in learning outcomes and of the time involved for faculty members to teach with visuals prompted this project.

Accessibility Issues. Obtaining access to visuals such as simulation games, DVD recordings, or audio/visual tapes via postal services are problematic due to import fees, international exchange regulations, and the extensive length of transportation time it takes to receive goods. The cost of videos can range from approximately twenty dollars (United States Dollars, USD) to five hundred dollars USD depending on the content (Watson, 2006). Other problems such as video distribution rights and identifying appropriate content before receipt of the tape further complicate the ability to access videos (Watson, 2006). Utilizing videos that are readily accessible over the Internet is one way these problems can be circumvented.

Streaming videos may be viewed during the process of download (Sharp, 2002), which saves time and space if the file is not saved on the computer. However, the proper hardware and software is required before streaming videos can be accessed over the Internet (Smaldino et al, 2004; Watson, 2006). Each website reviewed indicated what type of software was needed to play the video. Most websites in this study provided a link to download the software required to play the video.

Despite the aforementioned accessibility issues, obtaining videos for teaching is vital to the university's ability to provide a variety of modality experiences for student learning. One problem with the lack of access to supplemental materials in a timely manner is that students may become uninterested, if they do not have the necessary tools to study and complete their

assignments. Dissatisfied students interact less with peers and faculty, which generates a cycle of non-participation (Stage, 1989).

Electronic books (e-books) on CD-ROM, the Internet, streaming videos, MP3 Players, online simulation games and other related computer software programs have served as intervention tools for improving academic performance and increasing students' interest (Grant and Bladh, 2006). Although Grant and Bladh's research did not involve the physical sciences, it is presented here as an example of using the web as an instructional intervention resource

Contextual framework. While the faculty members of this university, many who are experts in their respective fields, represent industrial and developing countries. Our students are mainly from the Anglophone Caribbean countries. Sixteen countries are part of the university system with three major campuses at Mona, Jamaica, St. Augustine, Trinidad, and Cave Hill, Barbados. In addition, there are 13 satellite campuses.

Barbados is the easternmost island of the archipelago, bordered by the Caribbean Sea on its West Coast and the Atlantic Ocean on its East Coast. The population of the island is approximately 260,000 with 166 square miles. The population is approximately eighty-five percent African descent and fifteen percent Asian, European or mixed descent. The map in Figure 1.0 depicts the Caribbean region which UWI serves. Note that the easternmost location of Barbados with respect to the USA and South America.

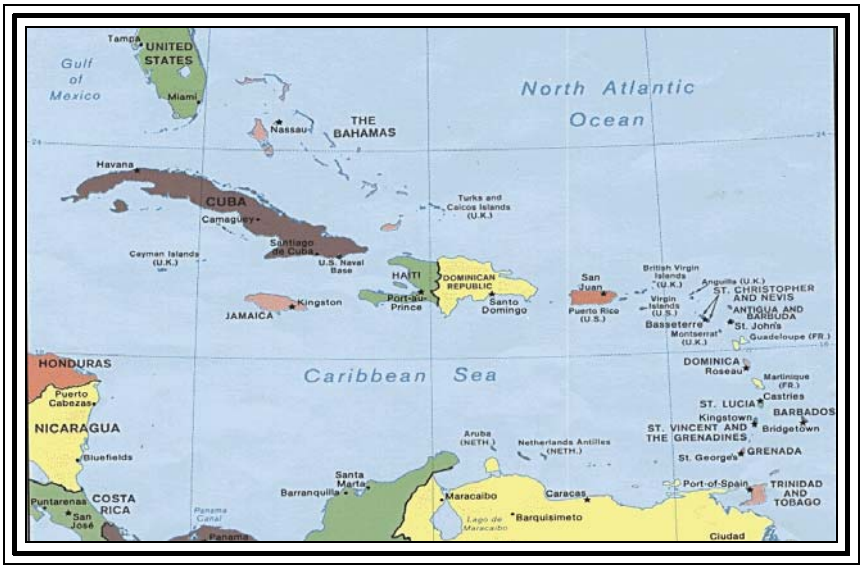

Figure 1.0: *Regional Map of the Caribbean*

Method

Searching Online Video Pages. At the time this research was initiated (June 2006) search engines had not catalogued videos as a separate database. Therefore, the search for videos was first conducted by inputting "physics demonstration videos" on the main search site. Finding appropriate videos involved investigating individual websites; many of which inadequately portrayed concepts and contents or were developmentally inappropriate. Screening each site for physics videos added a considerable amount of time to the task of assimilating this list of online videos. During July 2006, Google and Yahoo helped streamline this search process by introducing a separate category for online videos on their home page.

In order to obtain this short list of videos, it took approximately 16 hours per week for 12 weeks. The search path keywords were "physics demonstrations" which were typed into the video interface of the Google search engine. The same procedure was followed for Yahoo, Google and Alta Vista. The topic "physics demonstrations" on the Yahoo Home Page rendered a total of 90 hits; many of these sites were repeated. Without the quotes, the total hit on Yahoo was 339. Google's video interface search page rendered only one site when "physics demonstrations" was inputted (in quotes). Without the quotes, there were 26 hits; most of these were lectures that did not provide experimental demonstrations. Searching within sites revealed additional repositories of online video demonstrations which were also lodged within open courseware websites. Alta Vista's video search resulted in the identical information that was obtained via the Yahoo search engine. Searches were repeated again in August to determine whether any additional sites were available.

Results of Online Physics Videos Resources

A total of 455 hits produced less than ten tertiary level quality downloadable physic demonstration video websites and four animated demonstration websites. After twelve weeks of searching the various websites, a list of experimental and animated video websites are herein proffered. However, due to the ethereal nature of Internet resources the search for online videos of physics demonstrations must be an ongoing endeavor. The following websites are presented in the order that they were reviewed.

UWI Cave Hill Campus. The first website investigated was Dr. Sodha's which was available at http://scitec.uwichill.edu.bb/cmp/online/p10d/video/video.htm. The website offered online lectures which display explanation of the mathematical process similar to the way teachers use a blackboard. Although the website was not designed to primarily deliver videos, there were recordings of students engaged in scientific experimentation. The drawback of the website was there were only four video demonstrations offered. The affective benefit was that it offered videos in which Caribbean students were engaged in scientific inquiry

MIT Open Courseware. MIT the most prominent open courseware website may be accessed directly at http://ocw.mit.edu/OcwWeb/Global/OCWHelp/avocw.htm. Inserting the words "physics videos" in the search prompt displayed those websites that had demonstrations. There were 101 websites that mentioned or provided videos which could be explored by specific topics. After performing a cursory inquiry into the websites, it became obvious that not all of them had streaming videos.

Professor Levin's of MIT video lectures on electromagnetism was both informative and engaging. The website had 36 online lectures and physics demonstrations. The website offered several baud speeds, 56k, 80k, and 220k which made it easier to use than some of the other websites. See http://ocw.mit.edu/OcwWeb/Physics/8-02Electricity-and-MagnetismSpring2002/VideoLectures/index.htm for physics demonstrations within his lectures.

The Asian Institute of Technology featured the MIT Open Courseware on their library website as an online resource. http://www.clair.ait.ac.th/WebRes_OpenCourseware_MIT.htm.

Figure 2.0: *Asian Institute of Technology*

The University of Minnesota Physics Page. The online physics visuals at http://groups.physics.umn.edu/demo/ were offered by the University of Minnesota. The website did not provide an audio component. Brief clips of physics principles in action were presented without audio or electronic book explanations.

Civil Engineering Department (OSU). Ohio State University video demonstrations were well organized and appeared to be convenient for lecturers to use. Try it at: http://hcgl.eng.ohio-state.edu/~ceg413/html/geninfo.html at the bottom of the page. The website provided downloads of both a video and PDF of each concept. This website was offered by Keith W. Bedford of the Department of Civil Engineering for his Fluid Mechanics course. The University of Ohio streaming video could be played on Real Player. The website downloaded quickly and played without stalling.

Wake Forest University. The Wake Forest website provided a choice of streaming video or downloads with Real Player or MPG streaming or download. The Real Player downloads option worked best. As with Ohio State's website, downloading the video to the computer worked better than streaming. View Wake Forest University's online videos at the following website: http://www.wfu.edu/physics/demolabs/demos/avimov/bychptr/bychptr.htm

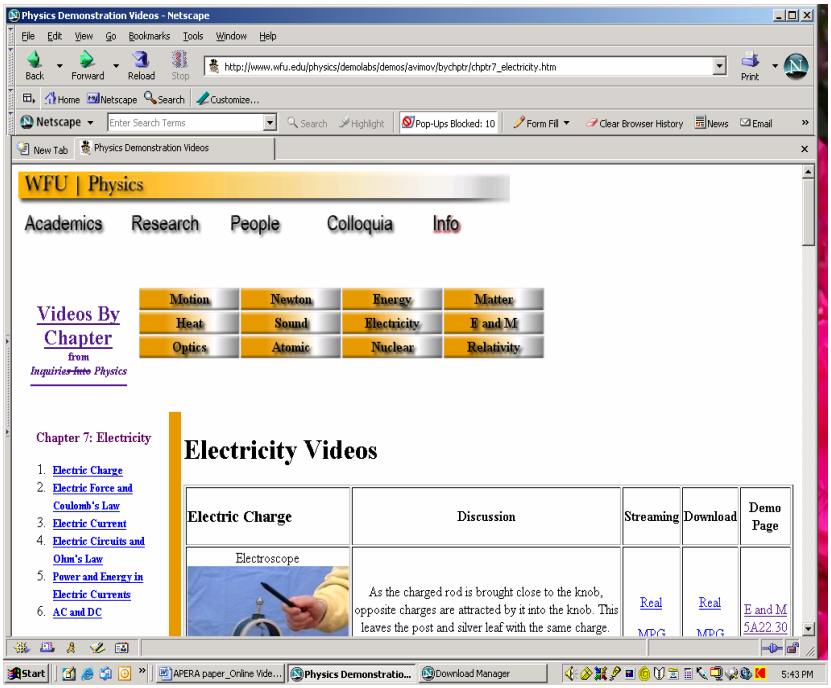

Figure 3.0: *Wake Forest University: Physics Video Website*

The University of Texas Physics Page. Several types of resources were available at http://www.ph.utexas.edu/~phy-demo/resources/resources.html. The Wake Forest University and the University of Wisconsin websites were found at this URL.

The University of Wisconsin. Professor Sprott had an enjoyable and informative website http://sprott.physics.wisc.edu/wop.htm which offered demonstrations and explanations of various physics phenomena that have been used as "magic tricks" throughout the ages. Some of these experiments were also available on MIT's Open Courseware website.

Results of Physics Animation and Simulations

Animated simulations of physics phenomena provided visualizations of counter intuitive physical laws. The following websites contained not only animated demonstrations but complimentary pages of electronic books which further explained the concepts.

The TEAL Project. This project offered by MIT provided applets to help students visualize the particle movements of electrostatics. The website also allowed users to comment on the use of its open source applets. The selection of applets for download were found at http://jlearn.mit.edu/tealsim/index.html.

University of New South Wales. The School of Physics at the University of New South Wales in Sydney, Australia offered an animated multimedia on the theories of relativity available online at http://www.phys.unsw.edu.au/einsteinlight/. The website provided short demonstrations which outlined the concept verbally. The explanations were reiterated in electronic book format on links associated with the page.

University of Virginia. Michael Fowler of the University of Virginia presented a series of applets. The page was available in English and Chinese versions. Six of the twelve applets provided visual explanations of planetary movements. The balance covered a variety of physics concepts.
http://galileo.phys.virginia.edu/classes/109N/more_stuff/flashlets/home.htm

Non-university sponsored websites. The website offered applets of various physics processes along with an explanation of theories and mathematical computation in some cases. The following website did not appear to be generated by a university or college: Available at http://physics.nad.ru/Physics/English/index.htm

Physics educators may find the Public Broadcasting Station (PBS) website useful for explaining String Theory. The theory was presented as a documentary where physicists were interviewed about the theory. This link offered illustrations about String Theory: Available at http://www.pbs.org/wgbh/nova/elegant/program.html

Conclusion

In the process of obtaining these few websites over 455 websites were scanned. Careful examination revealed that many of these hits did not actually have free streaming videos but information on purchasing videos online. Open 'videoware' database could improve accessibility, decrease cost, and increase integration into the curriculum. Searching the web and screening the websites as well as the videos was a time consuming endeavor which may hinder faculty members from embracing online videos as a supplemental resource. Therefore, there is a need to establish a central repository of streaming videos which briefly describes the content and the level of instruction. The fact that several universities recorded and uploaded their physics demonstrations to share with others indicated that science educators have recognized the value of online videos as an instructional tool.

In addition, it became evident after several weeks of searching that UWI, Cave Hill video demonstrations served an affective goal, since it portrayed underrepresented students engaged in scientific inquiry. No other website showed students of color as scientific investigators.

Videography

Asian Institute of Technology (AIT) available at: http://www.clair.ait.ac.th/WebRes_OpenCourseware_MIT.htm
Civil Engineering Department (OSU) available at: http://hcgl.eng.ohio-state.edu/~ceg413/html/geninfo.html
Free Science Online Blog available at: http://freescienceonline.blogspot.com/
MIT Open Courseware Videos available at: http://ocw.mit.edu/OcwWeb/Global/OCWHelp/avocw.htm
Physics Online http://physics.nad.ru/Physics/English/index.htm
Public Broadcasting Service (PBS) available at: http://www.pbs.org/wgbh/nova/elegant/program.html
TEAL available at: http://jlearn.mit.edu/tealsim/index.html.
University of Minnesota Physics Page available at: http://groups.physics.umn.edu/demo/
University of New South Wales Physics Page available at: http://www.phys.unsw.edu.au/einsteinlight/.
University of Texas Physics Page available at: http://www.ph.utexas.edu/~phy-demo/resources/resources.html
University of Virginia Mike Fowler's Page available at: http://galileo.phys.virginia.edu/classes/109N/more_stuff/flashlets/home.htm
University of Wisconsin-Madison Professor Sprott's Page available at: http://sprott.physics.wisc.edu/wop.htm
Wake Forest University Physics Videos available at: http://www.wfu.edu/physics/demolabs/demos/avimov/bychptr/bychptr.htm

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