Communication strategies for future space travel: A WebQuest to collect information to compare the use of microwave and radiowave technology in space communication

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Educational justification

The new Higher School Certificate (Stage 6) syllabuses, introduced in 2000 for teaching science in NSW schools, draw on constructivism, a pedagogy based on educational research relating to teaching and learning. Constructivism introduces classroom practices such as: understanding and responding to individual student interests, strengths, experiences, and needs; focusing on student understanding and use of scientific knowledge, ideas and inquiry processes; guiding students in active and extended scientific inquiry; cooperative and collaborative learning experiences; focusing on real world situations; activities that are largely problem solving; and providing opportunities for scientific discussion and debate among students. The new syllabuses also have a strong emphasis on current scientific information and issues and require students to gather information from a range of sources, including the Internet. Given the limited amount of time available to students there is very little to be gained from having the students surf the Web looking for material. Therefore a structured and guided approach to the use of the Web is essential.

Using the Web to teach physics

The Institute of Physics journal, Physics Education, Volume 37(2), March 2002, contained a special feature: Untangling the Internet. The articles outlined ways in which the Internet can be used to enhance the teaching of physics. Some of the situations in which you might use the Internet are:

- where delivery of the topic via the Web enhances or extends the learning experience;
- to illustrate things that cannot be observed directly, e.g. the Photoelectric effect;
- to simulate practicals that are inaccessible to the students because of safety or availability of equipment, e.g. emission and absorption spectroscopy of gases such as lithium and mercury;
- where students need to gather information, have access to current (daily) scientific data (e.g. solar activity) and be aware of latest research and discoveries in physics; and
- facilitation of collaboration between teachers and students from different institutions.

A good interactive applet, projected onto a large screen, is an excellent stimulus for discussion (Clinch and Richards, 2002, p111). Students can be asked to predict what will happen, and then formulate an explanation for what is observed through the simulation. This activity could be combined with worksheets to be completed later. Alternatively, prepared worksheets could be used to direct their prediction, observation and encourage the explanations of the simulated phenomenon or experiment.

There are some sites set up specifically to assist physics students in gathering information e.g. Physics Central http://www.physicscentral.com/.

Sites that have short articles reporting the latest in physics research, discoveries and developments are PhysicsWeb, http://physicsweb.org/archive/news/ and Physics News Update from the American Institute of Physics, http://www.aip.org/physnews/update/.

WebQuests as a teaching and learning experience

A number of web-based teaching strategies have been developed by two American educators, Bernie Dodge and Tom March, to ensure that students spend meaningful time accessing the Web. These strategies fall on a continuum from simple information retrieval through 'Treasure Hunts' to a constructivist approach in 'WebQuests'.

A WebQuest is an inquiry-oriented activity in which most or all of the information used by learners is drawn from the Web. WebQuests are designed for cooperative learning and peer assessment. The focus is on using information rather than looking for it, and supports student thinking at the levels of analysis, synthesis and evaluation. WebQuests give the students a clear well-defined task and suggested sites from which to gather information so that the students are not just surfing the Web. In addition, WebQuests not only satisfy the syllabus requirements, but also motivate the students.

To establish a WebQuest teachers do not need to possess any web authoring skills or to have access to a file server. What is crucial to a successful WebQuest is to identify a suitable topic that requires the learner to retrieve relevant material (primarily from the Web) and construct new knowledge in response to a statement, question or challenge or from a particular bias. WebQuests should target those topics where the Web provides the most current information (often not found in textbooks), specific applications and/or conflicting views on the topic. Identification of a suitable topic that satisfies the goals of WebQuests can be challenging. Incorporation of role-play into a WebQuest can encourage the cooperative learning that forms an integral part of a WebQuest.

Having decided on a suitable topic and approach, check that a suitable WebQuest is not already available. If not, then identify web sites that will provide the necessary information in order to achieve the desired outcome. Identify the various aspects of the overall topic and the possible roles that may be taken by participants and the interaction between the roles. Another important consideration is how to present the challenge in a novel but meaningful way.

Web sites such as Filamentality (http://www.kn.pacbell.com/wired/fil/) have been established to help educators create their own WebQuests and to host the resources developed. Care should be taken to up-date any WebQuest that you produce on a regular basis, as periodic culling is carried out to remove out-of-date and poorly maintained WebQuests.

To achieve efficiency and clarity of purpose, WebQuests should contain at least the following parts:

- an introduction that sets the stage and provides some background information;
- a task where the outcome is achievable and interesting;
- a set of information sources needed to complete the task;
- a description of the process the learners should go through in accomplishing the task;
- some guidance on how to organize the information acquired; and
- a conclusion that brings closure to the quest, reminds the learners about what they've learned, and perhaps encourages them to extend the experience into other domains.

These features have been built into the template that is provided by Filamentality.

Our WebQuest

In the syllabus topic Space (9.2), students are required to:

- describe difficulties associated with effective and reliable communications between satellites and earth caused by:
    - distance
    - van Allen radiation belts
    - sunspot activity
- gather, process, analyse and present information to compare the use of microwave and radiowave technology as effective communication strategies for space travel.

The basic physics which students are expected to get out of doing this exercise would seem to be an understanding of the propagation of radiowaves through a medium like the Earth's atmosphere or the solar wind, and the effect of frequency on the properties of that propagation. In particular they will need to address the question directly: why is it that (relatively low frequency) radiowaves cannot get through the ionosphere but (relatively high frequency) microwaves can? That leads directly to an understanding of why radio is used for communication around the surface of the earth, but microwaves for communication with satellites. The less mundane topics of space travel communication can then be explored from a reasonable basis of understanding.

Now this is a big topic, and not much of the information necessary to discuss it properly is in ordinary textbooks. Therefore, in order to meet this requirement of this syllabus item, students will have to find for themselves, information on some or all of the following subtopics:

- the difference between radio and microwaves;
- the existence of the ionosphere, and its effect on radio propagation;
- the propagation of radiowaves around the surface of the earth;
- the effects of geomagnetic storms and solar flares on radio communication;
- the existence and kinematics of geostationary satellites;
- the use of microwave technology to communicate with satellites;
- the propagation of radiowaves in interplanetary space and time delays involved;
- the effect of the solar wind (and disturbances in it) on interplanetary radio propagation;
- experiences of manned trips to the moon, and space probes to the planets;
- results from the use of radar to map the surface of the planets; and/or
- some of the more futuristic proposals, like the 'space Internet'.

This is an ideal topic to organize around a WebQuest.

The title of the WebQuest developed to support these syllabus references is 'The Dish … the story of what we nearly didn't see … and why'. This can be found at http://science.uniserve.edu.au/school/quests/spacewq.html. It is hoped that students might be motivated by identifying the content with the popular film, 'The Dish' which recounted some of the communication problems that were experienced in 1969 when man first landed on the Moon. The title is a corruption of the film's tagline (As Neil Armstrong set foot on the Moon, our only link was a satellite dish in rural Australia with a few bugs (and a few hundred sheep) … based on the story of what we didn't see).

Rather than dividing the information to be collected based on possible roles, The Dish WebQuest addresses the four main issues that need to be considered when formulating a response to 'comparing microwave and radiowaves as effective communication strategies'. The web sites identified have been divided to address the following division of information:

- properties, propagation, transmission and detection of radiowaves;
- properties, propagation, transmission and detection of microwaves;
- the effects of solar activity and sunspots; and
- the effects of the various layers of the atmosphere including the van Allen radiation belts.

Having identified suitable web sites and the focus to be addressed by participants in the group, using a resource such as 'Filamentality', web sites can be easily assigned to roles or tasks. Some web sites may be allocated for study by all groups; others might be confined to a particular task or focus. The solution to the overall task is achieved by collaboration and cooperation between all members each now a specialist in their own field of research.

Having prepared a WebQuest, the information gathered and entered into Filamentality can easily be transformed into a Treasure Hunt which might be used for revision purposes, or if time is limited. With a web-based treasure hunt, students are provided with a fixed number of questions and a single web site that will provide the answer. The student must access the site and analyse the information in order to obtain the solution. This might involve some calculations based on information given on a site, or a response based on accessing an online simulation. A treasure hunt

that addresses the syllabus dot point listed above can be found at http://science.uniserve.edu.au/school/quests/spaceth.html.

Conclusion

The preparation of effective web-based learning activities such as WebQuests is challenging and time consuming. However, tools are available to facilitate the procedure and web access is available to ensure schools can make use of these resources.

References

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Hammond, R. (2002) Using the Internet to teach physics, *Physics Education,* **37**(2), 115-117.

Hannam, N. and Wilde, J. (2002) Physics.org - a window to the web, *Physics Education*, **37**(2), 122-127.

Yore, L. (2001) What is meant by constructivist science teaching and will the science education community stay the course for meaningful reform? *Electronic Journal of Science Education,* **5**(4) http://unr.edu/homepage/crowther/ejse/yore.html

Web sites for physics applets

Web address	Title	Syllabus reference
http://www.colorado.edu/physics/2000/waves_particles/wavpart3.html	Electric field due to point charges	8.3 Electrical Energy in the Home
http://members.tripod.com/~vsg/interf.htm	Young's slits simulation using variable wavelengths	8.2 The World Communicates
http://www-ed.fnal.gov/projects/labyrinth/games/index1.html	Fermilabyrinth – accelerator, detector and methods	9.8 From Quanta to Quarks
http://physics.berea.edu/~king/Teaching/ModPhys/QM/Photoelectric/Photoelectric.html	The Photoelectric Effect	9.4 From Ideas to Implementation
http://home.a-city.de/walter.fendt/phe/phe.htm	The Photoelectric Effect	9.4 From Ideas to Implementation

Physics web sites

Web address	Title	Syllabus reference
http://www.Colorado.EDU/physics/2000/index.pl	Physics 2000	various
http://www.exploratorium.edu/observatory/	The Observatory (includes Auroras: Paintings in the Sky, Solar Max and Sunspots)	9.2 Space
http://particleadventure.org/particleadventure/	The Particle Adventure	9.8 From Quanta to Quarks
http://www.glenbrook.k12.il.us/gbssci/phys/Class/BBoard.html	The Physics Classroom	various
http://amazing-space.stsci.edu/	Amazing Space	9.7 Astrophysics
http://www.explorescience.com/	Explore science	various
http://www.kie.berkeley.edu/KIE/web/hf.html	How far does light go? Debate	8.2 The World Communicates
http://education.nasa.gov/	NASA Education	9.2 Space 9.7 Astrophysics 8.5 The Cosmic Engine
http://teachspacescience.stsci.edu/cgi-bin/ssrtop.plex	Space Science Education Resource Directory	9.2 Space 9.7 Astrophysics 8.5 The Cosmic Engine

Information about WebQuests

Web address	Title	Comments
http://science.uniserve.edu.au/school/tutes/webquest/	WebQuests - A Web-based Tool for Teachers	Tutorial developed by UniServe Science
http://www.ozline.com/	Ozline	
http://edweb.sdsu.edu/webquest/webquest.html	The WebQuest Page	
http://www.kn.pacbell.com/wired/fil/	Filamentality	
http://www.edhelper.com/cat246.htm#wq	More Science WebQuests from edhelper.com	
http://209.15.142.32/cat246_more_webquests.htm	More Science	
http://www.web-and-flow.com/members/mthompso/antarctica/webquest.htm	Antarctica - the past, present and future	
http://www.geocities.com/ResearchTriangle/Thinktank/2693/research.html	Webquests or Online Research Modules	Australian WebQuests including one or two science based units e.g. Feral Animals in Australia and Home of the Future – Greenhouse Gas Emissions
http://www.glencoe.com/sec/science/webquest/	WebQuest Science	click on activities to activate menu

Physics WebQuests

Web address	Title	Syllabus reference
http://www.memphis-schools.k12.tn.us/admin/tlapages/energy.html	Energy	Stages 4 - 5
http://www.esc20.net/etprojects/formats/webquests/summer99/northside/margaretquest.html/default.html	A Star's Life	Stages 4 - 5
http://www.lfelem.lfc.edu/tech/DuBose/webquest/pictor/space.html	Are We Ready for life in Space?	Stages 4 - 5
http://www.esc20.net/etprojects/formats/webquests/misc99/ASTEROIDS/Default.htm	"Deep Impact" Can It Really Happen?	
http://education.nmsu.edu/webquest/wq/blackhole_webquest/hole5.html	Blackholes: Journey into the Unknown	9.7 Astrophysics
http://powayusd.sdcoe.k12.ca.us/nukeweb/	Nuclear power in seaside	
http://www.medford.k12.wi.us/mash/aca/Curricpages/nelsopgs/index.htm	This Cold House: Managing Energy	8.3 Electrical Energy in the Home
http://can-do.com/uci/lessons99/skateboard.html	The Physics of Skateboarding	8.4 Moving About
http://www.glencoe.com/sec/science/webquest/content/rollercoast.shtml	Roller Coaster Physics	8.4 Moving About
http://www.glencoe.com/sec/science/webquest/content/maglevtrains.shtml	Mag Lev Trains: Floating Locomotives	9.4 From Ideas to Implementation
http://www.kie.berkeley.edu/KIE/web/hf.html	How Far Does Light Go?	Stages 4 - 5
http://btc.montana.edu/ceres/html/disks1.html	Searching for Proplanetary Disks	8.5 The Cosmic Engine 9.7 Astrophysics
http://www.richmond.edu/academics/a&s/education/projects/webquests/mars/	Human Life on Mars: What's it like?	Stages 4 - 5

Constructivism and science teaching on the Web

Web address	Title
http://www.owu.edu/~mggrote/pp/construct/c_construct.html	The Importance of Activities in the Teaching of Science: Constructivist Perspective on Teaching Science
http://www.miamisci.org/ph/lpintro5e.html	Constructivism and the Five E's
http://umperg.physics.umass.edu/perspective/constructivism	A Constructivist View of Science Education
http://www.caosclub.org/constructivism.html	The Constructivist Theory of Instruction