

Teaching e-Science in the Classroom - A pack designed for educators

e-Science Talk is an EU funded project specialising in disseminating e-Science topics to the general public. The aim of this teaching pack is to provide you with tools so that you can teach about e-Science within either your current lessons, or as an additional enrichment activity such as during a STEM club.

So what is e-Science?

e-Science is a science that relies heavily on computation. But why do we need it? Every day many disciplines produce vast amounts of data that need to be analysed and correctly managed. A good example of experiments that produce a lot of data are those at CERN. However, e-Science extends beyond just particle physics. It also includes earth sciences, social simulations, art (animation and rendering) and bio-informatics. e-science has contributed to bringing about the rise of affordable and fast data processing.

e-Science can be divided up into areas dealing with different aspects of e-scientific computation. These include:

- Cloud Computing
- Grid Computing
- Volunteer Computing
- High Performance Computing

How can I teach e-Science?

As a teacher finding resources for your students to use can sometimes be challenging. As a primary aid to teaching e-Science we have produced a memory stick containing the e-Science City website. It can also be reached via the following website:

www.e-sciencecity.org

e-Science City explains aspects of e-Science in a very user-friendly way. It was designed for teenagers, therefore the information on the website shouldn't need simplifying.

An example lesson plan has also been created that you can choose to follow.



The lesson

This lesson plan is divided into two 60 minute lessons.

Learning Objectives

- All will be able to explain what e-Science is.
- Most will be able to explain a single aspect of e-Science in more depth.
- Some will be able to explain all aspects of e-Science in more depth.

Preparation

This lesson also requires either the use of a computing lab, or access to laptops. A projector with sound is also used for the starter and later towards the summary. The computing resources are used for the student's independent research.

Starter (5 Mins)

During this section of the lesson the teacher introduces the idea of e-Science.

Video (10 Mins)

Play the video explaining what e-Science is. This is around 8 mins and features the penguins from the Dreamworks film, Madagascar. The URL is below:

<http://www.youtube.com/watch?v=TGSRvV9u32M&feature=fvsr>

A search for "high performance computing Dreamworks" on Youtube will also provide a link to the video.

Introduction to Main (10 Mins)

In this section of the lesson the teacher will introduce the main activity. The main during lesson is an independent group research project. Pupils should be split into groups to examine the various types of e-Science. e-Science City can be used as the primary source but pupils should be allowed to use other resources as well. The main task is to create a two minute presentation about the subject area which they will present back to the class. For example this could be a presentation on cloud computing.

After the teacher has given the introduction, the class divides into groups of three. A hand out for each part of e-Science would then be circulated that describes in brief what the specific part of e-Science entails, and some guide questions for the presentation.

Main (60 Mins)

During this part of the lesson, pupils research there specific e-Science topic, and then produce a two minute presentation.

Final (25 Mins)

In this final part of the lesson pupils will present their findings back to the rest of the class.

Homework

Ask pupils to write and summarise all of the areas of e-Science, using the notes from their peers' presentations as well other materials.

Notes

The total run time of planned material is 110 minutes allowing for a 10 minute presentation spill over, as well as class settling.

This is just one example of a lesson plan using e-Science as a basis. Feel free to use the resources provided in any way you feel fit. For a STEM club you may decide to increase presentation length, and allow students to use more resources.



Sheets

To accompany the main lesson plan a number of subsidiary sheets have been created. These are designed as an aid for the student but can be expanded for teaching.

Grid Computing (GridCafé)

Grid Computing is the idea that a high performance computer system can be created by using many smaller machines/servers, and that are connected yet separted by distance This network of machines offers a huge amount of potential computing power and is often used to tackle some of the world's big scientific questions.

Your task is to create a presentation based around grid computing and present it to your classmates.

- What is Grid Computing?
- What are the five big ideas used in grid computing?
- What goes into building a grid?
- What are the origins of grid computing?
- What are the applications of grid computing?
- What projects are currently using grid computing?
- What are the disadvantages and advantages of grid computing?

These questions are only a guide. Try not to use these as titles to any slideshow, but adopt them using the presenter's own style.

Volunteer Computing (Volunteer Garage)

Volunteer Computing uses spare CPU cycles on everyday computers all around the world. For example if you are browsing the internet on your home computer you may be using up to 5% of the CPU cycles available to you. The objective of volunteer computing would then be to use the other 95% of your available CPU cycles to crunch data to help scientists solve big questions. One project is attempting to cure cancer with this technology!

Your task is to create a presentation based around volunteer computing and present it to your peers. Below are some questions that you might find useful:

- What is volunteer computing?
- What goes into building a volunteer computing network?
- What are the origins of volunteer computing?
- What are the applications of volunteer computing?
- What projects are currently using volunteer computing?
- What are the disadvantages and advantages of volunteer computing?

These questions are only a guide. Try not to use these as titles to any slideshow, but adopt them using the presenter's own style.



Cloud Computing (Cloud Lounge)

Cloud computing is a general term for providing computing based services over the internet. This can range from providing a storage solution for your data to actively hosting your website.

Your task is to create a presentation based around cloud computing and present it to your peers. Below are some questions that you might find useful:

- What is cloud computing?
- How does cloud computing work?
- What are the disadvantages and advantages of cloud computing?
- What are the origins of cloud computing?
- What are the applications of cloud computing?

These questions are only a guide. Try not to use these as titles to any slideshow, but adopt them using the presenter's own style.

High Performance Computing (HPC Tower)

High performance computing is the idea of creating a super powerful computer (often referred to as a super computer or a cluster.) It will be based in one location and will contain thousands upon thousand of processors. These can be both CPUs and GPUs. These machines are usually a colossal size, and are often millions of pounds to purchase.

Your task is to create a presentation based around high performance computing and present it to your peers. Below are some questions that you might find useful:

- What is high performance computing?
- How does high performance computing work?
- What goes into building a high performance computer?
- What are the origins of high performance computing?
- What are the applications of high performance computing?
- What are the disadvantages and advantages of high performance computing?

These questions are only a guide. Try not to use these as titles to any slideshow, but adopt them using the presenter's own style.

Other resources

Listed below is a whole range of videos on the topic of e-Science. It may be of use to include these in any teaching you may do.

- Nvidia Gaming in the Cloud - www.nvidia.com/object/cloud-gaming.html
- Cloud Computing Introduction - www.youtube.com/watch?v=QJncFirhjPg
- Cloud Computing Power Down - www.youtube.com/watch?v=yovofzw9cls
- HECTOR HPC - www.youtube.com/watch?v=_vRgyCLuXwM
- Nvidia Personal Supercomputer - www.youtube.com/watch?v=l8FUms1h-5U&feature=endscreen
- Building a Cluster - www.youtube.com/watch?v=WIVIX5jX9AQ
- Quantum Computing - www.youtube.com/watch?v=jR7yPfmtAg
- Using the Grid to Fight Cancer - www.youtube.com/watch?v=i9RaBibYLpA
- Seti@Home - www.youtube.com/watch?v=_alJV5aQR68
- BOINC - www.youtube.com/watch?v=8iSRLIK-x6A
- How Processors are Made - www.youtube.com/watch?v=-GQmtITMdas&feature=related
- Showing Grid Job Transfer Live - <http://rtm.hep.ph.ic.ac.uk/>

The resource about quantum computing can be used as an extension task for higher level students doing projects about high performance computing. A grasp of physics will be required by the teacher to explain what quantum computing is and how it works.



Extention - What is Quantum Computing?

A classical computer is based on the idea of a bit, which relates to 1 or 0 (on or off). However with a quantum computer a new idea based on quantum physics is used. This idea is a qubit. A qubit can be on (1), off (0) or both on and off at the same time (1 and 0). This third function is what defines a quantum computer and also is the source of a quantum computers immense power and capability.

But why use quantum computers? Some problems (like superconducting) would require an infentesimally powerful classical computer and an infinite amount of time to solve them, but can be simply solved by a quantum computer.

Quantum computers are the future, but many scientists and companies around to world are conducting research to try and make this future a reality!

A final word

Good luck with running this activity on e-Science! e-Science is a fairly new but has great potential and here at e-Science Talk we think more people should know about it. If you have any comments about this pack we encourage you to contact us.

e-Science Talk also writes some articles for a weekly online publication for ISGTW (International Science Grid This Week). If you would like up to date news stories from the world of e-Science this is the place to look. Feel free to visit the site or even subscribe for free.

e-ScienceTalk: www.e-sciencetalk.org

e-Science City - www.e-sciencecity.org

ISGTW: www.isgtw.org

Real Time Monitor: rtm.hep.ph.ic.ac.uk

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