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

**e-ScienceTalk is an EC-funded project specialising in communicating 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, either within your current lessons, or as an additional enrichment activity such as during a STEM club.**

### So what is e-Science?

e-Science is 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 from particle physics experiments at CERN. However, e-Science extends beyond just particle physics. It also includes earth sciences, social simulations, e-Humanities and bioinformatics. Developments in e-science have contributed to bringing about the rise of affordable and fast data processing.

e-Science technologies 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 to further their knowledge, especially of new scientific fields, can sometimes be challenging. As a primary aid to teaching about e-Science we have produced a memory stick containing the e-ScienceCity website. It can also be reached via the following URL: www.e-sciencecity.org

e-Science City explains aspects of e-Science in a very user-friendly way. It was designed to be understood by students aged 14–18.

An example lesson plan based on the site has been created that you can choose to follow should you wish.

### 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 several 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 task is an independent group research project. Pupils should be split into groups to examine the various types of e-Science. e-Science City should be used as the primary information source, but pupils can use other resources as well. They should create a two-minute presentation about e-Science research which they will present back to the class.

After the teacher has given the introduction, the class divides into groups of three. Hand-outs for each of the three specific e-Science areas would then be circulated that summarise the features and concepts behind that area, with some guide questions for the presentation.

### Main (60 Mins)

During this part of the lesson, pupils research their 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 as 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 subsidary sheets have been created. These are designed as an aid for the student but can be expanded for teaching. Sheet contents are summarised below.

### Grid Computing (GridCafé)

Grid Computing is based on the idea that a high-performance computer system can be created by using many smaller computers and servers connected together, though possibly separated by great distance. This network of machines offers a huge amount of potential computing power and is often used to tackle some of the world's biggest scientific questions.

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

*   What is Grid Computing?
*   What goes into building a grid?
*   What are the origins of grid computing?
*   What scientific areas currently use grid computing?
*   What are the advantages and disadvantages of grid computing?

These questions are only a guide. A good presentation will adapt them to suit your 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 only 5% of the CPU cycles available to you. The objective of volunteer computing is to use the other 95% of your available CPU cycles to crunch data and help scientists solve big questions. One project is attempting to find a cure to 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 scientific areas currently use volunteer computing?
• What are the advantages and disadvantages of volunteer computing?

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### Cloud Computing (Cloud Lounge)

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

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• What is cloud computing?
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### High Performance Computing (HPC Tower)

High performance computing requires extremely powerful computers, often referred to as supercomputers. Unlike the grid, these are based in a single location and can contain thousands of processors. These can be both central processing units (CPUs) and graphics processing units (GPUs). These machines are usually a colossal size, and can cost £millions to build.

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?
• What goes into building a high performance computer?
• What are the origins of high performance computing?
• What scientific areas currently use high performance computing?
• What are the advantages and disadvantages of high performance computing?

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## Other resources

Listed below is a whole range of videos on the topic of e-Science. These may be useful 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=WlVlX5jX9AQ
- Quantum Computing - www.youtube.com/watch?v=jR7yPlfmtAg
- Using the Grid to Fight Cancer - www.youtube.com/watch?v=i9RaBIbYLpA
- Seti@Home - www.youtube.com/watch?v=_aIJV5aQR68
- 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 folowing resource about quantum computing can be used as an extension task for higher-level students. A grasp of the concepts of quantum physics is will be required by the teacher in order to explain what quantum computing is and how it works.

## Extension - What is Quantum Computing?

A classical computer is based on the concept of binary bits, 'switches' that are either 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 somewhere in-between. This third aspect is what defines a quantum computer and is also the source of a quantum computer's immense power and capability.

But why use quantum computers? Even with the most powerful classical computers, some scientific problems, such as code-breaking and simulations of molecules, can take a long time to solve. They can be solved much more quickly with a quantum computer, however.

Quantum computers may be 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-ScienceTalk we think more people should know about it. If you have any comments about this pack we encourage you to contact us.

e-ScienceTalk also has an online weekly publication: 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 and 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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