

SUN

PROMINENCES AND FLARES
Massive prominences, reaching tens of thousands of kilometers above the solar surface, are outcroppings of chromospheric gas flowing high into the corona. Occasionally, hot gas bearing amounts of radiative energy, breaks out along a prominence and has dramatic effects on Earth, disrupting communication signals and bringing on auroras.

SPOTS
Sunspots appear where shafts of intense magnetism force their way through the solar surface. They are cooler than the surrounding photosphere and are surrounded by a dark umbra, a penumbra, and a more or less period of relative quiescence.

CORE
The core holds half the Sun's mass, considered to be just one-eighth as hot as the rest of the sun. The temperature is about 150 million degrees Celsius. The gas pressure is about 200 billion times that of atmospheric pressure at Earth's surface. Nuclear fusion is taking place for five billion years. They will likely last for the billions of years to come. Some 100 billion tons of energy are being released from the beginning of our present epoch.

RADIATIVE ZONE
The radiative zone is filled with abundant energy, traveling out from the radiating core. Like a wall of invisible dielectric particles, it resists the flow of energy. It is a radiation trap, and the energy is carried from particle to particle for some 100 million years before it reaches the Sun's surface.

CONVECTIVE ZONE
The convective zone starts about two-thirds of the way out from the core, where the energy begins moving outward. Material that gets too hot to rise is pushed to the surface, where it cools and sinks back to the core, where it is heated again to rise. This cycle repeats itself over and over again.

PHOTOSPHERE
As the photosphere, energy being carried deep inside the Sun finally escapes and flows into space. The photosphere is the visible surface of the Sun. It is about 400 kilometers thick. Only 100 kilometers deep, it is the source of the Sun's energy. The photosphere is the source of the Sun's energy. The photosphere is the source of the Sun's energy.

CHROMOSPHERE
The outer layer or chromosphere, is a tenuous layer of gas, thousands of kilometers thick with temperature rising from about 10,000 degrees Celsius at the bottom to 100,000 degrees Celsius at the top. It is the source of the Sun's energy. The chromosphere is the source of the Sun's energy.

MAGNETIC FIELD
A powerful magnetic field dances out of the Sun. Near the poles it forms a torus and contracts with the heliopause and the folding action of the Sun's rotation. Such things as sunspots, prominences, and flares are all linked to the Sun's internal magnetic activity. The X-ray image above shows several coronal mass ejections out of the magnetic field structure just above the Sun's surface. The variation in brightness reflects differences in plasma temperature and density. Image: SOHO, ESA & NASA

ALGORGIOUS BALL OF MOSTLY HYDROGEN AND HELIUM GAS, the Sun is three hundred thousand times more massive than Earth and more than a trillion times as hot. Like a pressure spring in a vast and empty desert, the Sun contains a fiery mass of a cold, dark substance. Shining with the heat of four and-a-half billion twenty megaton hydrogen bombs every second, the Sun is a vigorous fountain of energy.

The Sun

Mass	1.99×10^{30} kilograms
Diameter	1.39×10^6 kilometers
Luminosity (energy radiation)	3.86×10^{26} watts
Core temperature	16,000,000° Celsius
Surface temperature	5,800° Celsius

If the Sun were the size of the Earth then the Earth would be this big

The diameter of the sun is 1,392,000 km, which is over 100 times the diameter of Earth (12,756 km). Although the Sun looks about the same size as the Moon, they both appear about half a degree of the sky. The Sun is actually 400 times bigger and the Moon is 400 times further away. Image: NASA/JPL

COMPARISON
The Sun is by far the largest object in the Solar System and a star. The Sun is by far the largest object in the Solar System and a star. The Sun is by far the largest object in the Solar System and a star. The Sun is by far the largest object in the Solar System and a star.

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Introduction

Digi-Posters – a union of digital and print media – support a wide range of teaching and learning approaches in science and other subjects. In particular, they support learners’ own exploration of a topic, making it immediate and relevant.

Digi-Posters is an idea developed by the GovEd Communications consortium as part of the Faraday Project. The consortium comprises GovEd Communications, Alligan, Feilden Clegg Bradley Studios, Futurelab and Soda Creative. Springboard Design Partnership were sub-contracted to provide design expertise.

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Background.....	3
Description.....	4
Proof of concept	5
Using Digi-Posters	6
Development.....	7

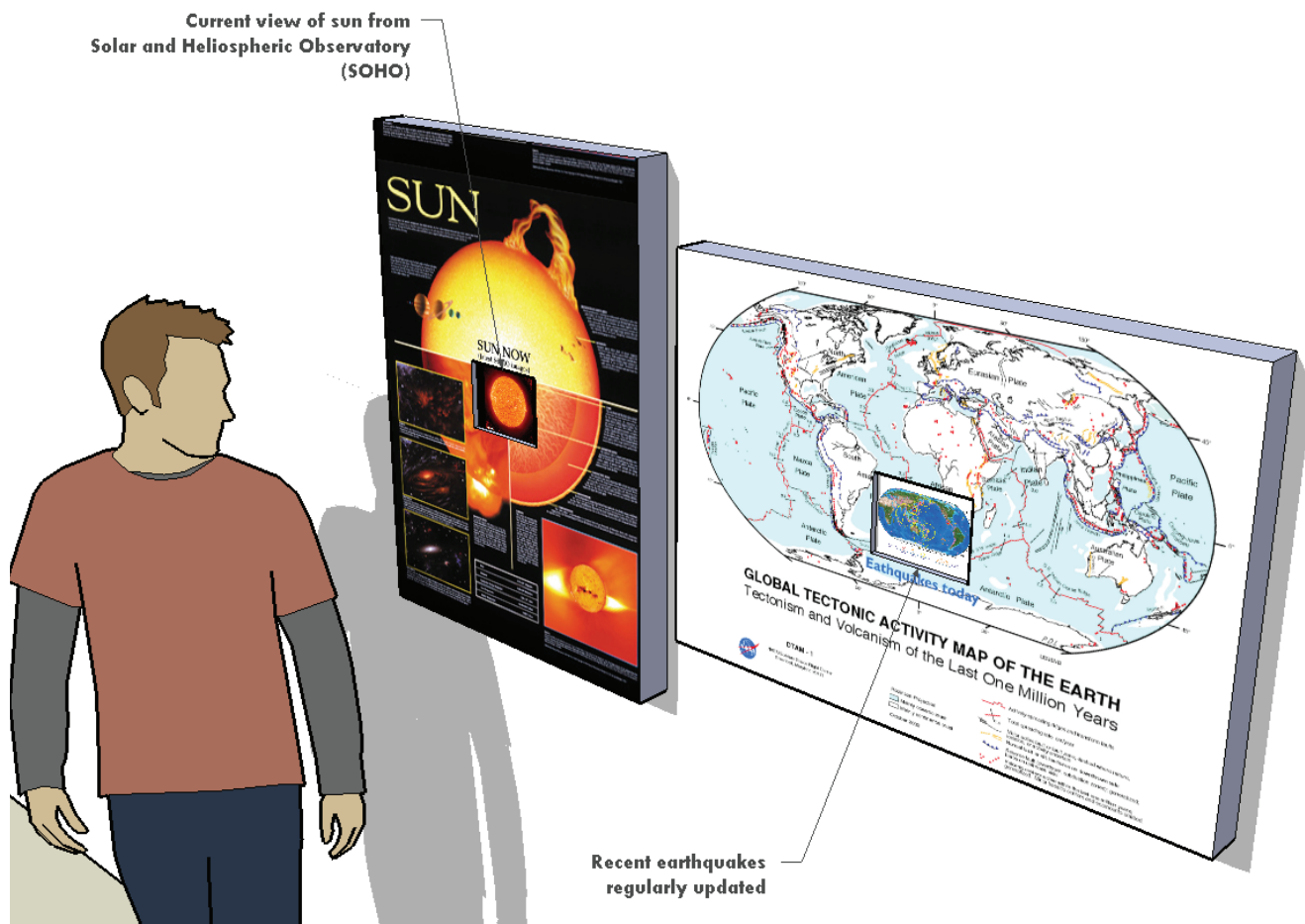
Background notes

Posters play a range of roles in schools today. The various reasons teachers use them include the facts that they:

- Give a room a scientific feel
- Inspire learners to think
- Remind learners of key ideas
- Prepare learners for new topics
- Help learners to consolidate their understanding
- Encourage learners to aspire to be scientists
- Bring information that would otherwise be hidden in books or websites out into the open
- Make learners smile
- Cover up cracks in the wall

However, posters are rarely used to their best advantage. The main problem with posters is that they are static. Learners cease to notice them after a very short period of exposure. One answer is to replace posters with digital displays, and these are increasingly common in schools. However, there are many aspects of posters that digital displays cannot replace – not least the fact that posters are cheap. Although digital displays are coming down in price, they will never be as cheap as paper – or display images as beautifully. Digital displays provide science education with new opportunities, but it would be a shame to throw the baby out with the bath water. We can get the most value from digital resources by focusing on what they do well rather than forcing them to take on roles better served by non-digital media.

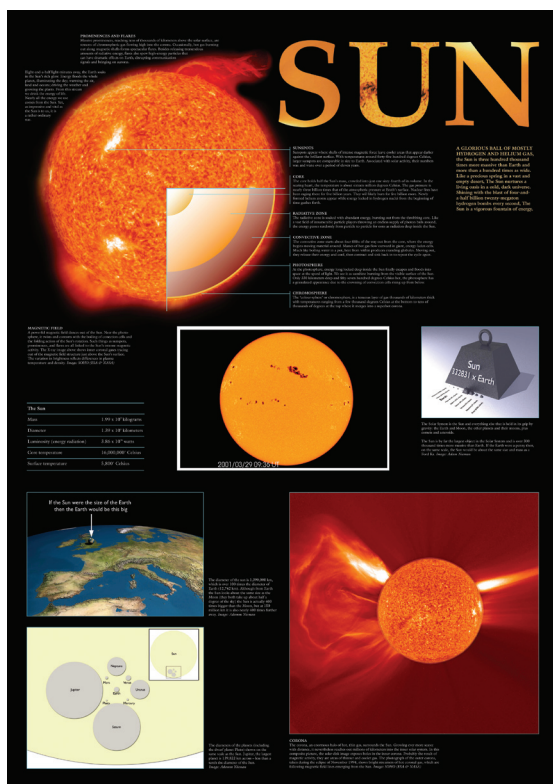
It is currently very difficult for students to engage with cutting-edge science initiatives such as The Human Genome Project, The Large Hadron Collider and space missions such as Cassini-Huygens. Posters are the traditional medium scientists use to explain their work to each other, but in schools they lack impact and immediacy. A Digi-Poster is not an 'experiment' in its own right but it can play a vital role in allowing interactive experiments to meet modern expectations of science education. Therefore Digi-Posters enable a strong synergy between print and dynamic digital displays backed up with an informed and engaged online community.



Digi-Posters: Description

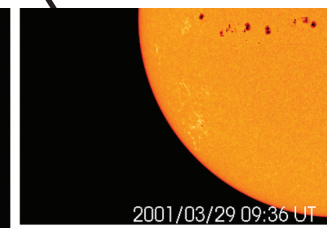
Simply put, a Digi-Poster is a printed poster that incorporates a digital screen (a large one or a small one). The value of Digi-Posters comes from the combination of digital and printed content – enhancing the strengths of each medium. Printed material can display a far higher density of information than a screen at much less cost. (For an LCD screen to carry as much information as an A1 poster it would have to have pixel dimensions of 9,600 x 7,200 pixels, which would give it physical dimensions of 3.4 metres x 2.5 metres.) Unlike ordinary posters, Digi-Posters are always current – displaying the latest results and live images.

However, they go further than a screen by itself would because they put the current results into context. The advantage Digi-Posters have over websites is that they do not require students to go looking for them – students can ‘opt-in’ whenever the content catches their eye. In several areas of the curriculum that teachers have identified as problematic, teaching can be supported by this combination of live content and contextual information including space, environmental chemistry, ecological relationships, and nuclear physics. There is scope for Digi-Posters to make a range of different contributions to science education.



Near real-time images and movies displayed on the screen supported by graphics and text

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The diameter of the sun is 1,390,000 km, which is over 100 times the diameter of Earth (12,742 km). Although from Earth the Sun looks about the same size as the Moon (they both take up about half a degree of the sky) the Sun is actually 400 times bigger than the Moon, but at 150 million km it is also nearly 400 times further away. Image: Adamu Nicman

Proof of concept

Stellar and solar physics is a topic that teachers have told us is difficult to teach, because it seems abstract to students and removed from their lives. The proof of concept prototype takes as its starting point a commercially available educational poster about the Sun. It is a well designed resource but, as with all posters, learners' engagement with it will begin to wane soon after their first glance. Also it does not help to make solar physics 'immediate' or relevant.

Near real-time images and movies from the Solar and Heliospheric Observatory (a spacecraft that observes the Sun from a special orbit) have the immediacy that the poster lacks – they show what is happening on the Sun 'right now' – but learners would need to go in search of them and would not always understand the significance of what they were looking at if and when they found them.

The Digi-Poster version shows how combining digital content with printed information adds value to each. Because they are almost 'part of the furniture', real-time images of the Sun do not require special research from the student – they are always available. This gives learners a chance to develop an awareness of the Sun and follow its changing behaviour without any effort. The explanation of solar physics on the poster provides a context for the images and movies, which makes the learners' gaze richer and more informed. Students are motivated to read the text and understand the diagrams because they have real phenomena going on in front of their eyes that require explanation. The graphic representations of the Sun's scale helps students to see what a remarkable thing a star is.

The construction of the poster itself is described in the appendix (Design Notes).

Using Digi-Posters

Though not ‘experiments’ in their own right, Digi-Posters can play an important role in interactive experiments by simultaneously placing them in context and displaying results. Posters are one of the most important forms of communication in science (along side journal articles and research seminars) and have far more potential in school science than has been realised to date. We see them being used in a number of ways. In particular they would be useful in links to live research (including students’ own experiments); providing visual examples that help explain difficult topics such as waves and chemical bonding; and as a way of displaying student work.

- **Sun Live:** Poster about the Sun that displays near real-time images (supplied by the Solar and Heliospheric Observatory) of the Sun at various wavelengths.
- **Cassini Live:** (In collaboration with the Science and Technology Facilities Council) a poster about the Cassini Mission to Saturn with the very latest images (and captions) displayed as they become available each day.
- **Atmospheric Chemistry and Remote Sensing:** A poster about the atmosphere with the very latest satellite images from the Earth Observation Programme including Total Ozone, Global Temperature, etc.
- **Our School Now:** Live and accumulated data (including, for example, data related to energy consumption, CO₂ emissions, etc.) with explanations of what the various numbers represent.
- **Vibrations and Waves:** A poster that explains key concepts in vibrations and waves (a difficult topic) with animations.
- **Seismology:** A poster that explains plate tectonics, maps the motion of the plates in great detail and also provides live information about recent earthquakes.
- **What goes on in a real lab?** The digital content is a webcam image of a working lab in the Royal Institution, a local university, or another friendly institution. The printed content describes the equipment being used and the layout of the lab and the kinds of activities being pursued.
- **Ecological Relationships:** Using webcams and RSS to display images and data collected remotely. The printed content describes the species involved.
- **Today at CERN:** A live link to CERN with the latest results from the Large Hadron Collider (or, rather, from the education outreach team there). The printed content would provide all the background needed to understand the illustrations and press releases.
- **Student experiments:** A class conducts a series of experiments, films them and writes them up. The details and results are presented on a poster, just as they would be in professional scientific contexts. They are either laid-out in Microsoft Publisher (or similarly accessible program) or they are glued directly to an A1 template. The video of the experiments runs on the screen.

Development

The availability of low-cost networked displays aimed at consumers means that the production of Digi-Posters in small numbers is feasible. However, there are other routes that developers should consider. Some design solutions simplify the distribution of media for Digi-Posters and can remove any need for configuration of the device itself. An easy to use web page could give a teacher control of all the Digi-Posters in the school. Any content on the web could be directed to any of the screens. (We would expect access to this configuration page to be limited to prevent anyone directing inappropriate material to the screens.)

The Digi-Poster network would be driven by a small device (a low cost Linux server) which itself would require no configuration. Unlike the concept prototype, the screens would be simple and would not need to contain memory or any of the other components required by consumer devices. Instead, they would have a small networked box that would do nothing but act as a target to which the server would direct media.

In addition to simplifying configuration, there are other advantages of having a network of Digi-Posters rather than merely having Digi-Posters on a network. It could also simplify the distribution of posters and support the sharing of resources between schools. Both teachers and learners would have an opportunity to share their work and build on the work of others. There are good exemplars of community focused sites where users of a web-service determine what is produced. In other domains examples include the business card service www.moo.com and community t-shirt site www.threadless.com.



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