Dippy on Jour A Natural History Adventure



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KS3 Science - What can we learn from Dippy?

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The visit of Dippy to Rochdale represents an amazing and inspiring opportunity for our students as they prepare for adulthood in a fast-changing world.

Whether they are simply awe-struck by the sheer scale of Dippy or get deep into all sorts of questions about the past and future, Dippy has the potential to have a lasting impact on us all in Rochdale.

Aims

These materials are designed to support schools visiting Dippy at Number One Riverside and engaging with all the other activities around Dippy, so that there is lasting impact for students.

Specifically:

- To develop students' thinking around sustainability. Although this is not a specifically identified in the KS3 Science Programme of Study; schools may decide that this is a key part of an ambitious and broad curriculum, including citizenship education.
- To support the development of students ability in working scientifically.

(See Appendix for curriculum information and GCSE links).

All resources are designed so that they can be used without editing but mediation by teachers will be a vital part of bringing the experiences to life. All resources are will be made available in editable format to allow extra flexibility (TBC).

Ways to use Dippy to support Learning in Science

- Enrichment activities which sit separately from your school's science scheme of learning
- · Activities which can be dropped into lessons to further enrich the teaching and learning

Both options have the potential to exist as or as one-off activities, although the former has the potential to lead to richer, more embedded learning.

Overall approach

These enquiries, for KS3 students, are intended as open ended activities where students follow their own lines of enquiry, stimulated by a series of big questions linked to Dippy. The emphasis is on the enquiry aspect and expanding students' awareness and thinking more than pursuing a series of "right" answers.

The lines of enquiry are linked to "Working scientifically", "Relationships in an ecosystem" and "Genetics and evolution" in the KS3 Science curriculum.

Enquiries are provided for each of the two main themes in Rochdale: working scientifically and sustainability.

Theme A – Working Scientifically KS3 Enquiry 1

How could we find out more about why Diplodocus- became extinct?

KS3 Curriculum links

• Understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review

Potential PoS and broader learning objective(s)

- We are learning to judge how strongly evidence supports or counters suggested explanations/ conclusions/theories
- We are learning use evidence to suggest explanations

Strands of enquiry, prompts and supplementary questions for students

- What competition from other species would Dippy have faced?
- What environmental conditions is Dippy adapted to?
- If Dippy was alive today, could it survive? What evidence supports this? What other evidence could help us decide?
- What is the evidence about the numbers of species in danger of extinction today?
- What is the evidence for natural disasters, such as an asteroid impact or prolonged volcanic activity causing the extinction of Diplodocus? What is the evidence for alternative explanations?

Teachers notes

A key part of this enquiry is for students to consider different evidence and to judge how firm any conclusions drawn can be.

The fossil record shows that there was a mass extinction of all Dinosaurs, except for birds, 66 million years ago. There is strong evidence that there was an asteroid impact in Mexico area at the time of the mass extinction. The crater, which is largely now buried, is 150km in diameter and in its locality there is an unusually high level of the rare metal iridium, just as there is in meteorites. It is believed that local devastation and the amount of material which filled the lower Earth atmosphere, so lowering sun light availability and temperature, impacted the entire global ecosystem, with many extinctions, in including most of the dinosaurs.

However Dippy had already been extinct for many millions of years at the time of the asteroid impact. In addition, there is evidence for extensive volcanic activity (unrelated to the asteroid) which also added material to the atmosphere, further blocking the sun's energy. There is evidence of general climate change at the time but the extinction rate would be spread over a longer period than with the catastrophic mass extinction that appears to have occurred.

It is believed that birds survived due to:

- Their small size. This means they needed less food and allowed shorter time between generations, so they evolved faster and adapted to the new environment
- Their varied diet
- Their ability to fly so that they can colonise new areas more easily

Dinosaurs evolved at a time when the earth's climate was hotter and many plant species that existed then are now extinct. Students can be encouraged to speculate if the right conditions exist on parts of Earth today; whether a suitable diet is available and what competition would exist.

Teachers Notes

Other useful information:

- Mostmeteorites have come from asteroids which have survived impact with the earth's surface although some are composed of material from the Moon or from Mars
- Birds are considered to be dinosaurs and evolved from small theropods which are meat-eating dinosaurs. The earliest bird fossils are about 150 million years old

More information can be found on the Natural History museum website: www.nhm.ac.uk/discover/how-an-asteroid-caused-extinction-of-dinosaurs.html



KS3 Enquiry 2

Is it possible that Diplodocus was just too big to be successful in the long term?

KS3 Curriculum Links

- Pay attention to objectivity and concern for accuracy, precision, repeatability and reproducibility.
- Apply mathematical concepts and calculate results
- Present observations and data using appropriate methods, including tables and graphs
- Interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions
- Present reasoned explanations, including explaining data in relation to predictions and hypotheses

Potential PoS and broader learning objective(s)

- We are learning to calculate and use % to support comparisons
- We are learning to design effective ways to present data about animals
- We are learning to use evidence to support explanations and conclusions
- We are learning to recognise when there is uncertainty in explanations and theories

Strands of enquiry, prompts and supplementary questions for students

- Calculate and compare the % of Dippy's mass with that a variety of current day animals are e.g. a mouse, a Labrador, a lion, an eagle, an elephant, a dolphin, a whale, as ostrich
- Create visual display comparing the size of Dippy to other animals
- Why do different species differ in size and shape so much? How does mass affect an animal's ability to run or fly? What advantages and disadvantages are there for Dippy being so large?
- How does the size of today's biggest land animals compare to the biggest marine ones? What could explain this? Where does Dippy's size fit into this picture?
- Is there a relationship between animal size and bone diameter? What are implications for Dippy?

Teachers Notes

Students can be given the opportunity to decide how best to display the information they uncover; paying attention to visual impact and to accuracy. They should be encouraged to be specific about the data they are using e.g. the exact species, age (adult?) and gender. Also they may suggest and justify which is the most meaningful when comparing animal sizes: mass/weight; height; length.

The question about the variety of size of different animals leads into the huge area of study of how each species is adapted, through evolution, to different habitats, diets and ways of life. It is almost too big a question and can lead students to collect huge quantities of biological information, so focusing them onto specific questions such as the one suggested may be advisable. When exploring these lines of enquiry, using the internet, students are likely to find many sources that are not easy to use/understand and this also applies to the relationship between animal size and bone diameter. A useful starting point for this is:

galileo.phys.virginia.edu/classes/609.ral5q.fall04/ LecturePDF/L14-GALILEOSCALING.pdf Or www.bio.miami.edu/tom/courses/bil160/bil160goods/17_ scaling.html

Throughout this enquiry, students can be encouraged to provide evidence for their explanations and conclusions. They can evaluate the sources of information for reliability, the degree of certainty in their explanations, theories and conclusions based on the quality of the evidence and the extent to which different sources agree.

Theme B – Sustainability KS3 Enquiry 3

How could we live in better harmony with our environment?

KS3 Curriculum Links

- The interdependence of organisms in an ecosystem, including food webs and insect pollinated crops
- The importance of plant reproduction through insect pollination in human food security
- How organisms affect, and are affected by, their environment, including the accumulation of toxic materials

Potential PoS and broader learning objective(s)

- We are learning about human influence on global and local environments
- We are learning to judge what conclusions are possible from complex data
- We are learning to evaluate the strengths and weaknesses of different courses of action

Strands of enquiry, prompts and supplementary questions for students

- Could Dippy have lived in the North West of England in the past? Could Diplodocus live in the North West of England today, if the species had not become extinct?
- Where, why and how have habitats been lost or damaged in our area? What pressures have led to habitat loss? What steps have been taken to reduce impact? Are these steps sufficient?
- Where, why and how have habitats been lost or damaged in other parts of the world? What pressures have led to habitat loss? For example, what effect is happening with palm oil and the rain forests?
- Where does climate change caused by humans sit compared to climate changes due to other causes? Over what period of time have the various changes in climate occurred? What could have been the implication for living things, including Dippy?
- How does the way we live have an impact globally?
- What changes are realistic for us to make to make? What changes are not under our direct control? How could we influence other people, including governments and corporations?

Teachers Notes

This is a very rich area for enquiry, but great potential for students to follow threads which capture their imagination. They can link their enquiry closely to Dippy or focus more on the wider picture.

Sitting at the core of this enquiry is human activity's damage to/destruction of habitats and Enquiry 4 focuses specifically on the almost universally accepted human influence on global carbon dioxide levels. Students are encouraged to speculate about past events, based on evidence they find. For example they may see that there is a lot evidence for changes in climate throughout time and suggest how this could link to changes in habitats and survival of species.

In Rochdale the Kingsway Business Park development will have resulted in loss of habitat but creation of "green corridors" through built-up areas including Kingsway help to maintain healthy communities that would struggle to thrive in small, isolated areas. Students should be able to appreciate the frequently opposing forces of growth and prosperity against maintaining habitats. Leading on from their research, they may be able to develop arguments about whether a suitable balance is being achieved.

Teachers Notes

The example of palm oil production in areas of rain forest which has been cleared for the purpose illustrates a change of global importance. Palm oil is very widely used around the world and the economic opportunity for developing counties is very attractive. Its production is fuelled by demand and although individuals can try to choose products which do not contain palm oil, political and commercial action would greatly help matters.

Students may start to see that not all choices are quite as simple as they seem at first. For example, alternatives to palm oil may also have their negatives and could lead to food which is more expensive.

When investigating the complex issues around human influence on the planet, some students can start to feel overwhelmed by what they see as the hopelessness of the situation with increasing global population opposing all the changes we make for the better. As teachers we need to be ready to put a case for hope and for action!



KS3 Enquiry 4

What do carbon footprints have to do with Dippy?

KS3 Curriculum Links

• Changes in the environment which may leave individuals within a species, and some entire species, less well adapted to compete successfully and reproduce, which in turn may lead to extinction

Potential PoS and broader learning objective(s)

- We are learning about the role of atmospheric CO₂ on Earth's climate
- We are learning how/why climate affects species' ability to thrive
- We are learning to evaluate complex evidence from a variety of sources
- We are learning how our personal choices can contribute positively and negatively to Earth's climate

Strands of enquiry, prompts and supplementary questions for students

- What changes have there been in Global atmospheric carbon dioxide level since Dippy was alive?
- How were Dippy and the other living things around at the same time affected by the concentration of carbon dioxide in the atmosphere?
- How do we find out what atmospheric carbon dioxide levels were in the past?
- What are the influences on the level of carbon dioxide in the atmosphere?
- Why should global carbon dioxide levels be of any concern to us?
- What is meant by "carbon footprint"
- Construct a continuum to show the range of possible actions to reduce global CO₂; at one end are things we have most control over e.g. walking short journeys instead of going in a car; towards the other end are things that are harder for us to change e.g. availability of public transport. The continuum could be annotated with notes to say how we could increase our influence when things are hard to change e.g. through campaigns and through the choices we make as consumers.

Teachers Notes

Throughout geological time, Earth's climate has changed due to factors such as variations in the orbit of the Earth around the sun and changes in the positions of the land masses. In Dippy's time (the late Jurassic; 155-145 million years ago), it is believed that levels of carbon dioxide in the atmosphere were around 1000ppm, i.e. a lot higher than today. Particularly around the oceans, the climate was warm and humid and plants thrived. For an indication of timescale: the modern form of humans only appeared about 200 000 years ago and it is believed that what we would recognise as civilisations have only existed in the last 6000 years.

In the 800 000 years leading up to 1950, global CO₂ levels have fluctuated between approximately 180 parts per million (ppm) and 300 ppm. The 2013 level is over 400 ppm and it is continuing to rise. The size AND speed of the change is what is causing grave concern. The rapid change coincides with our use of fossil fuels. The Intergovernmental Panel on Climate Change states "Scientific evidence for warming of the climate system is unequivocal." Although there is not complete agreement, 97% of climate scientists agree that climate warming trends are extremely likely to be due to human activities.

Teachers Notes

A good source of information, which easily understood by KS3 students is: https://climate.nasa.gov/evidence/

The political dimension to global climate issues may start to interest students.

https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions provides in-depth information about CO₂ production and additional contextual information across the world.

Students should be able gain an idea of what their carbon footprint is and some relatively easy steps they can take to reduce it. However they will probably start to realise that even "easy" steps require commitment and persistence. There are various footprint calculators for carbon and other factors on line which vary greatly in complexity e.g. the straightforward one from: https://footprint.wwf.org.uk/#/ or more complex ones that require a lot of information to be entered e.g. https://www.carbonfootprint.com/calculator.aspx. All have the potential to increase students' awareness.

There are hints within the calculators such as whether we buy locally sourced produce or not. Even this is not as straightforward as it seems as; for example, the long-term storage of apples has a considerable carbon footprint such that eating local apples out of season may in some cases have a larger carbon footprint than imported ones.

Appendix

KS3 Curriculum Links

Working Scientifically

- understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review
- apply mathematical concepts and calculate results
- present observations and data using appropriate methods, including tables and graphs
- interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions

Subject content

- heredity as the process by which genetic information is transmitted from one generation to the next
- a simple model of chromosomes, genes and DNA in heredity, including the part played by Watson, Crick, Wilkins and Franklin in the development of the DNA model
- differences between species
- the variation between individuals within a species being continuous or discontinuous, to include measurement and graphical representation of variation
- the variation between species and between individuals of the same species meaning some organisms compete more successfully, which can drive natural selection
- changes in the environment which may leave individuals within a species, and some entire species, less well adapted to compete successfully and reproduce, which in turn may lead to extinction
- the importance of maintaining biodiversity and the use of gene banks to preserve hereditary material

Preparing for GCSE Science

One of the purposes of KS3 science is to give students a strong foundation of scientific skills and understanding which will allow them to develop further in more changing concepts and higher level skills at GCSE.

The main areas

- explain how some abiotic and biotic factors affect communities
- describe both positive and negative human interactions within ecosystems and explain their impact on biodiversity
- explain some of the benefits and challenges of maintaining local and global biodiversity
- describe evolution as a change in the inherited characteristics of a population over time through a process of natural selection which may result in the formation of new species
- describe the impact of developments in biology on classification systems
- Explain how evolution occurs through natural selection of variants that give rise to phenotypes best suited to their environment
- Describe evidence for evolution, including fossils and antibiotic resistance in bacteria

Appendix

References

National Curriculum in England: science programmes of study (Updated 6th May 2015).

www.gov.uk/government/publications/national-curriculum-in-england-science-programmes-of-study/ national-curriculum-in-england-science-programmes-of-study#key-stage-3

• Combined science GCSE subject content (June 2015; for examination from 2018).

www.gov.uk/government/publications/gcse-combined-science

• Ofsted Education Inspection Framework (Published May 2019).

www.gov.uk/government/publications/education-inspection-framework

• Ofsted School Inspection Handbook (Updated Sept 2019).

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/ file/828469/School_inspection_handbook_-_section_5.pdf