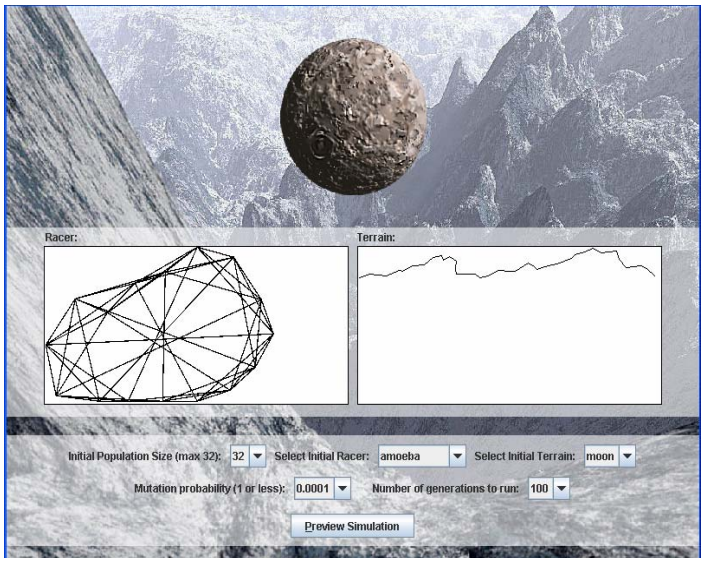
Lesson Plan for 'Natural Selection'

A Brief Synopsis

- ***Introduction*** [15 minutes]
  - Brief talk introducing pertinent issues.
  - Question and answer session, the purpose of which is to encourage pupils to think about how genes are inherited
- ***Main*** [25 minutes]



Pupils will use the 'Planets' feature of our software and will be able to experiment with it, thereby gaining an insight into the way that creatures can evolve over a period of time.

Pupils will report back on their findings.

- ***Conclusion*** [15 minutes]

Questions and answers revisited, giving the pupils a chance to appreciate what has been learned.

Pupils will be asked to fill in a questionnaire.

- ***Concurrent simulation***
  - Whilst the lesson is taking place, a simulation (or several) can be run, concurrent to, but separate from, the other activities. Progress can be monitored from time-to-time but will not require constant attention.

Key Teaching Metaphors

- ***Each planet represents a different environment***.
- A Sodacreature represents a real-life animal or being. ***Different types of Sodacreature represent different species***.
- When a Sodacreature is raced, this race can be thought of as a ***race for survival***. The ***quicker*** a Sodacreature is, the ***greater its reproductive success*** is.
- ***Failure*** to ***complete*** the course can be likened to having a ***lethal disease.***
- The ***selective force*** in ***Natural Selection*** is that of ***reproductive success***. This is analogous to the ***selective force*** used in the ***software***, which is the ***time a Sodacreature takes to complete a race*** in its given environment.
- The vast time-scale is represented by 'Soda-time' (greatly condensed).
- The continued ***improvement in performance***, over time, represents the continued ***successful adaptation*** to that specific environment. This adaptation might prove to be unsuccessful in a different environment.

Links to the National Curriculum (based on Edexcel GCSE Double Award)

- understand how adaptations such as…allow survival in particular environmental conditions (2.31)
- describe how new species may evolve from variants which are better adapted to their environment (2.34)
- explain how natural selection can lead to evolution or extinction of species (2.36)

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Key Teaching Points

- Creatures change over time. More precisely, changes to the ***genotype*** (coding of the genes) determine changes in the ***phenotype*** (appearance and performance).
- This change is guided by ***Natural Selection***, whereby the alterations ***best suited to the environment give rise to greater reproductive success***. In this way, the advantageous mutations are passed on to subsequent generations.
- Therefore, ***creatures adapt in different ways to different environments.*** After a long enough period, creatures, in different environments may have diverged to such an extent that ***new species*** have been created. Breeding between different species will almost certainly fail.
- Most changes are ***not beneficial*** (but some are) and too many at one time will result in a lack of success.
- Therefore***,*** the process of ***evolution*** is that of the ***gradual accumulation of small but advantageous changes over a vast time-scale.***
- A creature ***inherits its genetic components*** from its parents. The recombination of existing genes provides a near endless source of variation. Therefore, subsequent generations of creatures retain a resemblance to their ancestors.
- Rare mutations to genes in harness with the recombination of existing genes provide the material for changes to the genetic make-up of individuals of a given species.

The Lesson Plan in More Detail

Preparation

Install our software on the required number of computers, which will require:

- Access to the Internet.
- 'Windows'.
- Java installed.

Check these issues for all machines before attempting the lesson.

The teacher should become ***familiar with the software***, specifically, the '***Planets***' feature. In addition, if wishing to run an on-going simulation (or more than one), then he/she should become familiar with that part, as well.

The Lesson Plan

1. ***Set up an ongoing simulation***, which will last for the duration of the lesson. (It will not take up any time unless prior access to the classroom is not possible, in which case, maybe 2 minutes to set up). *This requires a computer, dedicated to the task* (could set up several of these simulations but each simulation would require a dedicated computer).
   a. Go to the '***Planets***' feature of the software and choose to '***run a new simulation***'. Follow instructions (tool tips).
   b. This simulation will run, unaided, using our software and the Sodarace application. Over the course of the hour, generations of Sodacreatures will compete in races. The Sodacreatures will interbreed and mutate and will evolve from one generation to the next. The progress will be recorded automatically.
   c. *Pupils can be referred to this during the introduction.*
   d. Periodically, between the other stages, the pupils can check the progress of the simulation (2 minutes each time).

Links to the National Curriculum Specific to this Simulation

- explain how sexual reproduction… leads to variation in the new generation (2.07)
- recall that some alleles cause diseases, which can be inherited (2.20)
- understand how adaptations such as…allow survival in particular environmental conditions (2.31)
- describe how new species may evolve from variants which are better adapted to their environment (2.34)
- explain how natural selection can lead to evolution or extinction of species (2.36)

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2. ***Introduction***, ***Question and Answer Session*** (15 minutes).

Introduction

a. Explain that living things have changed over a vast period of time and suggest that this process of change is explicable by the theory of ***Natural Selection***.
b. Explain that the force driving 'Natural Selection' is that of ***reproductive success***.
c. Give familiar examples of evolution:
    i. Humans and chimpanzees from common ancestors.
    ii. All breeds of dog from wolves, etc.
d. Explain that specific parts of creatures have evolved, with examples:
    i. Bats using sonar (shape of face, etc.)
    ii. Eyes
    iii. Shape of human larynx to allow speech, etc.
e. Explain that there is variation within a species and still greater variation between species. Is interbreeding possible?
f. ***Introduce Sodarace and our software***.

Question and Answer part: open-ended questions, many of which can be repeated at the end to see what has been learnt. For example:

g. What is the mechanism of passing on hereditary information?
h. How can this mechanism ensure similarity between members of the same species?
i. How does variation amongst a species arise?
j. Are there random elements regarding evolution.
k. If so, why does Natural Selection lead to better adaptation, in general?
l. How can we explain different strains of the same species?
m. What can cause evolution to progress in different ways?
n. What is meant by genotype/phenotype?

Also, consider issues as outlined in the 'Key teaching Points' section.

3. ***Main*** (25 minutes, including the feedback session).
    a. ***Use the 'Planets'*** part of the software and choose '***pre-run simulation***'.
    b. Pupils will be able to choose ***several versions*** of a Sodacreature, each ***representing it at various stages of its evolution*** in a pre-run simulation.
    c. Having made the choice of versions, pupils will be able to run them in a '***Soda Race***' and see how the creature has 'improved' over time.
    d. These simulations will show how each Sodacreature has evolved (potentially in different ways) on each different planet (which will have its own environment).
    e. The pupils might also be able to see how well, or badly, Sodacreatures that are adapted to one environment fare in a different one and how successful (or not) crossovers between different adaptations can be.
    f. This session will illustrate:
        i. The effect of the environment on evolution.
        ii. How some designs are better adapted to a given environment than others.
        iii. How species adapt to an environment.
        iv. Therefore, as environments differ, how ***different species*** can evolve.
        v. Pupils should be able to deduce that 'Natural Selection' works by ***accumulating small*** but advantageous changes over a vast period of time.

    Feedback Session (5 – 10 minutes)
        a. Each group/pupil will report their findings and compare experiences.
        b. Pupils can enter a debate on the various aspects encountered.

d) ***2nd Question and answer session + Questionnaire*** (15 minutes)
   a. Similar questions to those posed earlier, an opportunity for reflecting upon what has been learnt.
      i. Perhaps ask why it is that sometimes the creature may have appeared to evolve into a very different form, very rapidly.
   b. Open forum. Pupils can ask questions about evolution, Sodarace and our software, etc.
   c. In conclusion, pupils should be asked to reflect on the way that Natural Selection uses mutations and recombination (both random) but that due to the struggle for resources, Natural Selection itself is not random.
   d. Hand out questionnaire during the final Q & A session. The questionnaire should include questions such as:
      vi. Have the pupils learnt about evolution? (If so, what?)
      vii. Has the software been beneficial in this respect?
      viii. Has the software been fun?
      ix. Was it easy to use?
      x. Any improvements/issues?

e) ***Following Up.***
   a. At a later opportunity, keen pupils should be able to use the parts of the software that they did not use during the hour lesson.
   b. They will be able to learn more about the ***inheritance of genes*** and how the ***genotype*** (coding of the genes) determines the ***phenotype*** (appearance and functionality).
   c. This will give them an insight into the fact that alterations to the genes determine changes in appearance and functionality.
   d. This will give them more opportunity to compare mutation with recombination and to notice the different ways in which they work.
   e. They should be able to understand that variation is random but that the more suitable variations will achieve more reproductive success and that this represents the process of ***Natural Selection***.
   f. Pupils can run longer simulations (as in part 1). This will make it very clear that selective pressure can give rise to better-adapted creatures without having a 'grand designer'.
   g. ***One of the other lesson plans can be followed***.