In an ideal world

Given a high level of resources, how could ICT transform a practical science lesson? Consider this scenario. The teacher brainstorms the background science ideas behind the experimental work using an interactive whiteboard or Mimio. The work is saved as a web page or put into a shared file from the laboratory via a radio link to the network, so that the pupils can use it that night.

The pupils undertake the experiment using data-logging equipment and take digital pictures and a video of the results of their experiment. The pupils finish the experiment and have a quick discussion among themselves before linking, via a webcam, to another school in another part of the country to discuss their experiments further. The teacher plays back the images and data from earlier work to refresh and review the topic undertaken. The pupils go home and write up the experiment using an authoring tool or word processor incorporating sound files of their method, video and pictures of their experiment. They also incorporate graphs and an analysis of their results with the help of a spreadsheet program. During this process the pupils use resources from the Internet or link to copies of relevant CD-ROMs on the school’s network to support their
work. The finished experimental report can be mailed to the teacher or put in the shared homework folder waiting to be marked electronically. The above scenario can really happen at my school but not necessarily with all these features at the same time. But it is exciting and stimulating to work in this way for both teachers and students.

How can we work towards this approach to teaching science? This chapter aims to explore some of the ways in which the elements discussed above are currently used in a comprehensive school and the impact they are having on the work of the science department.

The Cornwallis School

Writing from the perspective of a practising science teacher at the Cornwallis School (an 11–18 technology college with approximately 1575 pupils, in Maidstone, Kent), I have rooted this chapter in my own classroom experiences, recognizing nevertheless that Cornwallis is unusually well resourced in terms of information technology. It has almost 200 laptops and over 190 desktop computers and is a regional centre for the National Opportunities Funded (NOF) ICT training for teachers, a mentor school for Microsoft and the first school in England to have a campus-wide wireless network.

In the science department of 17 teachers, there is access to a set of 20 laptop computers, and each laboratory has up to four desktop computers available. The class sizes never exceed 25, which makes it possible to have a ratio of two pupils per computer in the laboratories. The department has two half-sets of data-logging equipment giving similar pupil access. One set uses Acorn pocketbook computers with Data Harvest Sense and Control data-loggers, while the other makes use of laptop computers and Data Harvest Easylog data-loggers.

While the school and the science department are currently far from typical, they do provide an indication of the likely impact that an ICT-rich environment might have on the workings of a school science department. In most science departments there are a range of factors which can impede the use of ICT, such as access to computers, peripheral devices and, significantly, the knowledge to use them effectively. Other factors that have been suggested include the lack of suitable teaching materials (Tebbutt 2000). This chapter explores the potential benefits and the organizational and other departmental issues that arise when many of these barriers are removed.

ICT in the science curriculum

Communication is at the heart of all scientific activity and is itself a key aspect of science education. The term communication is being used in its
widest sense to include not only speaking and writing but also TV, radio and video, all of which can be linked and controlled by a computer. The use of ICT enables the pupils to save time and provides clear and effective ways of presenting scientific information. Table 1.1 shows some of the ways in which ICT can be used to assist the process of communicating within science lessons.

Table 1.1  ICT tools to aid communication in science lessons

<table>
<thead>
<tr>
<th>Software program</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft Word</td>
<td>Experiment reports, writing frames, templates, drag and drop activities</td>
</tr>
<tr>
<td>Microsoft PowerPoint</td>
<td>Slide shows and simulations</td>
</tr>
<tr>
<td>Microsoft Excel</td>
<td>Labelling activities</td>
</tr>
<tr>
<td>Macromedia Flash</td>
<td>Animated simulations of experiments and scientific concepts</td>
</tr>
<tr>
<td>Microsoft Frontpage</td>
<td>Web pages</td>
</tr>
<tr>
<td>Macromedia Dreamweaver</td>
<td>Web pages</td>
</tr>
<tr>
<td>Matchware Mediator</td>
<td>Web pages</td>
</tr>
<tr>
<td>Hot Potatoes</td>
<td>Crosswords and cloze exercises</td>
</tr>
<tr>
<td>Microsoft Visio</td>
<td>Memory maps, timelines, flow charts of experiments and food chains, labelling activities</td>
</tr>
<tr>
<td>Various</td>
<td>E-mail and video conferencing</td>
</tr>
</tbody>
</table>

In addition, programs such as the ones cited enable pupils to give added depth to written reports by including a results graph, a digital image of the equipment or videos of an experiment. The pupils can include hyperlinks to related documents or websites, thus enhancing, rather than replacing, more conventional means of communicating ideas and information. For example, pupils who can access a video of their experiment have a visual aid that helps them to follow and review the experiment at home. This will help them to write their methods, see the results again and evaluate their work much more effectively.

As with other subjects, science is now charged with the development of basic skills such as numeracy and literacy, and here again ICT offers opportunities for extending the learning in many aspects of the conventional science curriculum. Spreadsheets can support pupils in calculating formulae or modelling numerical relationships; sliders and scroll bars, part of the Form toolbar in Microsoft Excel, allow pupils to ascertain the relationships between numbers and specify which formulae the relationship could refer to (see Figure 1.1).

ICT can help numeracy in other more subtle ways, such as using the zoom facility in graphing software as an aid to understanding scale factors. A range of the software features provided in many graphing packages can provide useful tools to assist pupils in this area of the curriculum. Pupils
can often change instantaneously between different types of chart and graph to find the one that is more suitable for their data. In addition, the creative use of Microsoft Excel can produce spreadsheets and graphs that model pyramids of number looking at feeding relationships in ecosystems (the use of spreadsheets is discussed in more detail in Chapter 7).

ICT can also play an important part in supporting literacy work. Pupils writing about scientific concepts such as investigations, reports or work on historical ideas can be helped by using templates or writing frames, making the frames more (or less) explicit depending on the ability of the pupil. Supportive text provided by the teacher can be hidden on screen to stop it being printed out, allowing just the pupils’ work to be seen. The example in Figure 1.2 shows how a letter template, using hidden text for prompts in Microsoft Word, can help pupils to structure their ideas about the developments Robert Hooke made on the light microscope.

Pupils can also use Microsoft PowerPoint to write presentations about historical characters and developments, incorporating sounds and even animations. Scientific spellings can be checked by pupils by using activities that use macros and conditional formatting in a product such as Excel, and at my school we have often found the pupils more confident and creative in their use of language with such support available to them.

Later in the book we will explore in detail the use of software that is
particularly relevant to science teaching, such as data-logging software, information sources on CD-ROM and the Internet, and spreadsheet software. Clearly the use of these types of applications form the core of the ICT-related work within the science department. At this stage I want to provide an outline of the range of ways in which we have found ICT useful in science lessons.

Data-logging software is a particularly important application in science since it forms the interface between practical work and the use of ICT. Using and interpreting information from secondary sources are also important activities in science education. Common activities involve searching and using information from CD-ROM databases and the Internet. Other activities include using database software such as Information Workshop or Microsoft Access to create and interrogate databases on, for example, the planets of the Solar System, the periodic table or the classification of organisms. The information-handling activities I find most effective are Internet scavenger hunts and database activities on genetics data, such as ‘Do tall people have big feet?’ (Chapman et al. 2001). In this latter activity pupils look at continuous and discontinuous variation by making databases of their class results and using scatter graphs to study relationships between different physical attributes of the class. Therefore they can hypothesize
about the relationships between the variables, for example in ‘Do tall people have big feet?’ measure the variables, analyse the data and draw conclusions easily using this software. There are also secondary data from another school so that pupils can compare their data with a larger sample.

Models allow pupils to change the variables in a scientific system and see their effects. Pupils start by learning how to manipulate simple models and progress to making their own. Simulations are often seen as a subset of this type of activity. Models themselves can also be broken into two groups: static models, such as those used for calculations such as an electricity bill, and dynamic models, which look at the changes within a system over a period of time (Carson 1997). There are many excellent commercial simulations currently available such as those in the New Medias Multimedia Science School, Maxis’s SimLife and Crocodile Clips. SimLife provides a method of looking at food chains and evolution as the students can place different organisms on their own worlds and watch what happens to them very quickly over time. They can even invent their own organisms by amalgamating different parts of those already available. Multimedia Science School has many different types of simulations, ranging from those modelling particle theory and elements to those that model velocity and blood glucose levels.

Activities using spreadsheets such as Microsoft Excel have many more uses than just graphing and calculating formulae. For example, scientific images can be imported into Excel and labelled by inserting comments. Simulations, including the graphics, can be made using macros (a macro is a series of commands and functions that is stored in a Visual Basic module). They can be used to make activities that allow pupils to simulate the effects of different materials in blocking different types of radiation or the effect of changing the mass and distance of a planet on the gravitational pull of that planet. These activities allow students to experiment independently to find out how the relationships between the variables change. They are scientific concepts that pupils could not study by themselves or in practical situations.

**Virtual learning**

Over the past two years we have focused a great deal of energy evaluating different mechanisms for the delivery of online resources to support teaching at all Key Stages. As well as forming what we termed virtual classrooms on our own website, where resources for our courses could be downloaded, we have used several different ‘portal systems’ in a similar manner. The most common one used is Digitalbrain, often characterized as a virtual learning environment. Although the use of these within the classroom has not had an apparent significant impact yet on the achievement of the pupils at Key Stages 3 and 4 they have proved useful:
• in providing resources or extra homework to pupils in order to support their learning during their courses and at times when they need extra support, such as study leave and holidays;
• for e-mentoring of pupils through the portal’s e-mail and chat forum facilities;
• to include all pupils in the learning process, even those who are ill or excluded;
• to organize ICT resources or science courses.

It is also apparent that these environments may have their greatest impact on those courses and subjects that have a large amount of assignment-based coursework, such as the applied science GCSE course. We are still evaluating other environments such as Microsoft’s Encarta Class Server and Oracle’s Think.com and we need to scale up our studies to see how truly effective these environments are.

ICT as a motivator

It is very difficult to pinpoint exactly how ICT improves the performance of pupils in tests. One problem when looking for a direct relationship between the use of ICT and pupils’ performance in standard pencil-and-paper tests is that these tests are unlikely to relate directly to the skills being developed when using ICT. Assessment based largely on recall may well not reveal benefits in terms of improvements in conceptual understanding or the ability to analyse data more effectively. Considering the positive impact of ICT, one of the most important is probably due to an increased motivation for the subject (Musker et al. 1997). In science, visual aids, such as practical or video demonstrations, have always been used to explore difficult concepts and ICT can, especially in the form of simulations and models, greatly enhance the learning experience (NCET 1994a). It may be that the information presented in this way is put across in a different, more visually stimulating manner; for example, ICT also allows pupils to obtain results more quickly and easily and therefore allows them more time to interpret them. The results themselves, such as those from data-logging experiments, are more immediate and accurate. All these factors appeal to the pupils, especially the older ones.

Cornwallis is involved in using the materials produced as part of the Cognitive Acceleration through Science Education (CASE) programme, which emphasizes, among other things, the importance of classroom talk. Strong indications are that ICT can promote such discussion, enabling pupils to be more focused on their tasks and their discussion to be similarly focused. Simulations can be incorporated in ‘CASE-like’ activities to support the experimental parts of the lesson or in some cases instead of them. They should be used when they add an extra element to the lesson.
An example of this is density from explorecience.com. Students can study the effect of dropping shaped objects of different mass into a measuring cylinder to find their volume and on to a digital balance to find their mass. They can then drop them into a beaker to see if they float. The lesson can be structured to maximize the opportunities for pupils thinking but what takes this a step further is at that at a flick of a switch the density of the liquid used can be doubled or quadrupled. The objects rise to the surface and the students have to ponder why this happens. Discussion between pupils in lessons can also be encouraged using activities involving video clips in Microsoft PowerPoint or simple software animations using, for example, Macromedia Flash. The use of e-mail or video-conferencing means that these discussions or even those related to experiments or topic work do not have to be limited by the confines of the classroom (Musker 2000). In a project at my school called ‘Mission to Mars’, primary students video-conferenced with space research scientists at the Rutherford Appleton Laboratory after studying Moon rock and investigating how they could study the surfaces on the different planets.

At Cornwallis for over two years we have made use of a device called a Mimio, which when attached to an ordinary whiteboard enables everything drawn on the whiteboard to be displayed and saved on a computer. By using this device ‘concept maps’ can be created on the board, and each stage in building up the map can be saved to a computer (see Figure 1.3).

![Figure 1.3 Visio space ‘concept map’](image)
Replaying this file enables the steps used to be revisited or even modified in the light of new understanding.

Pupils themselves appear to feel that ICT has a great impact on their performance. In a study at my school (Musker et al. 1997) the following reasons were given by pupils as to why computers made science more interesting, although it would seem that these comments could relate just as well to other curriculum areas:

• it allows me to work independently;
• it makes tasks quicker and easier (‘I finish my work quicker when I use a computer’);
• it is more entertaining than ‘normal’ lessons;
• it is more visual;
• it improves presentation (a response made only by boys).

Further findings showed us that over 85 per cent of the pupils surveyed enjoyed using computers in science lessons and almost all of these thought their use improved their understanding of science topics, although this was just based on the pupils’ subjective judgement. The other 15 per cent of the sample did not enjoy using ICT in lessons. This group was predominantly made up of girls from lower band groups. These pupils stated that they preferred to have more traditional teacher-led lessons because these lessons needed fewer interactions from the pupils themselves (Musker et al. 1997). This would suggest that we need to reconsider how we introduce and support these pupils when using ICT. However, for the majority of pupils ICT has been found to allow flexibility for an individual’s learning needs; for example, pupils can work at their own pace and go over work they are unsure of with a computer (NCET 1994a). The type of activity used in the classroom also has an effect on the enjoyment of the pupils. In the Musker study, activities involving PowerPoint, CD-ROMs and the Internet were considered by these pupils as being the most enjoyable. These activities rated highly as they allowed the pupils the opportunity to work independently and the activities were more visual and sometimes more entertaining. Many boys also stated that they liked Microsoft PowerPoint as it improved their presentation and they could make it ‘look cool’ (Musker 2000), which is useful since it impacts on the motivation of such pupils. The tasks that involved using spreadsheets were deemed the least enjoyable, with activities using sensors and other software packages being rated between these activities (Musker et al. 1997). All these findings have allowed us to plan and write our activities taking into consideration what aspects of ICT the pupils enjoy doing and what may be the most effective uses of ICT for them.
Organizing ICT in a science department

Responsibility for ICT within a science department is often given to those who have the greatest enthusiasm, such as the ICT coordinator, or left to the head of the department to organize. More democratic departments may spend time developing their ideas and plans as a group. Whatever the situation, it is important to consider the following issues:

- the development of the ICT skills in science lessons;
- the purchasing of relevant resources to meet the specific needs of the department;
- the management of those resources;
- technical support;
- staff and pupil competence;
- staff training;
- how to evaluate whether the developments have been a success.

The development of ICT in a department starts with the identification of the needs and aims for ICT. A development plan can be drawn up to outline the targets, the time-scale for these aims and how they are going to be implemented. Furthermore, the plan should consider all the bullet points listed above and these will have to fit in with the school’s development plan for ICT and any ICT policies. The aims of the plan should also be prioritized (NCET 1994b). For example, it may be that developing data-logging in Key Stage 3 is a higher priority than developing it in Key Stage 4. I will now deal with each of these issues in turn within the context of the science curriculum.

Curriculum

ICT can be integrated into the majority of lessons but its use must be carefully monitored so that it is educationally justified. Initially the activities must be easy to implement and known to work. The type and number of activities chosen will depend on many of the considerations already highlighted, especially staff competence and resources. We have found it important that the activities chosen are written into the departmental schemes of work, to ensure there is sufficient time for their inclusion and so that pupils’ use of ICT is properly planned and monitored. Many departments now use schemes such as Eureka or Spotlight Science, which have ICT integrated into their course work, or use courses such as ICT Activities for Science 14–16 that provide step-by-step guides to implement a wide variety of ICT activities. Our department uses ICT activities from the Eureka scheme in conjunction with our own activities and some from other written sources, including ICT Activities for
These are planned to give us good coverage of the science curriculum that enhances learning and provides the pupils with opportunities to implement many different types of activity. ICT is also used in those topics in which it is difficult to incorporate practical work.

The department may also be involved in covering some of the requirements of the National Curriculum for ICT. It is possible to cover all the Key Stage 3 requirements within the science department but generally science departments in schools are expected to implement the measuring part of the ICT curriculum, through, for example, the use of data-logging equipment. In my department some of the most common experiments are: measuring the velocity of a trolley using light gates; investigating the rate of photosynthesis using an oxygen sensor; and studying neutralization using a pH sensor.

**Hardware**

There are many ways of using hardware and software in order to enable ICT to support the teaching of science. The number of computers available is obviously the biggest influence on how these activities will be managed. If the science classrooms have only a single computer it can be used as a demonstration tool, especially if a large monitor or, better still, a data projector is available. Single computers can also be used for extension activities or as part of a ‘circus’ of practical activities. If network rooms are available then science can use these effectively for all ICT activities except data-logging.

In my school, laptops are used widely, with many half-class clusters available around the school. We are also lucky to be supported by a radio network, which allows us to access the network in any of the rooms. Radio networks are already proving a success in many schools, as they allow teachers to teach in their own rooms, improving their confidence and allowing them access to the resources they use every day. Pupils can access all their ICT work wherever they are in the school, even on the school field. This ensures that their work is always saved and is also accessible to the teacher.

**Peripheral devices**

There are many extra pieces of hardware or peripheral devices that can make the curriculum more exciting or easier to implement. Some peripheral devices are a must, such as printers. Most now have infra red capabilities, allowing computers such as laptops to send documents for printing via this link. Table 1.2 lists some of the available equipment that I have found extremely valuable in science teaching.
An example: using digital video

Digital video cameras are expensive and they need suitable software to allow films to be edited. However, whole-class activities can be undertaken with just one camera and one computer for editing. A digital video camera can be used in any classroom and outside and is very portable. My
students can write, film and edit presentations in an hour’s lesson. We have used it to film virtual dissections, make interactive periodic tables and create plays about global warming. It has formed an integral part of my ‘ICT (Innovation, Creativity and Thinking) in Science’ project. Digital video is also an excellent way of observing lessons and analysing thinking skill lessons.

**Software**

The most common software in schools is probably the Microsoft Office suite of programs. This is very versatile software and all the programs can be used very successfully in science. There is also specialist software, which is discussed in detail in later chapters. There is much now that is good value for money but obtaining site licences for some of this software can be extremely expensive and you have to be careful not to break the terms of your agreements. Roger Frost (1997) has produced this helpful list to consider. Does the software fit the needs of the department in terms of:

- the curriculum targets;
- the learners’ needs;
- hardware capabilities;
- ease of use;
- cost?

And does it enhance the science curriculum?

Ideally you want the software to be cheap and easy to use, to suit the computers you have, to save time or make scientific concepts easier to visualize and to be generic so that it fulfils many roles. Software that easily fulfils all these criteria includes data-logging software such as Insight or DataHarvest’s Sensing Science Laboratory. National conferences such as the ASE Annual Meeting and the BETT Show provide a good opportunity to discuss ICT needs with many different software and hardware suppliers.

When you are considering which software, support materials and hardware to invest in, the needs of the pupils should be considered. This will include consideration of:

- educational and motivational qualities of the resources;
- pupils’ ICT capabilities;
- differentiation;
- grouping of the pupils.

We have found that the varied experience of Year 7 pupils means that using ICT early in this year is difficult. We have spent some time not only teaching ICT as a course in Year 7 but also spending a few lessons teaching the pupils how to use specialist software, such as the data-logging kit. As a result of liaison with some of our feeder primary schools we now teach pupils in Years 5 and 6 how to use data-logging sensors in science, in
preparation for their work in Year 7. Science teachers visit the primary school for a few sessions of about two hours to introduce and use data-logging equipment with the primary pupils. The teacher works closely with the primary staff to ensure that the science covered is suitable for the level of pupil and to build the links between the school.

**Support material**

There is a wide range of articles, books and on-line resources available to help teachers develop schemes of work to integrate ICT into their teaching. Journals such as the ASE’s *School Science Review* have articles on software, hardware and using ICT in the classroom. Websites such as SciShop, (www.scishop.org), another ASE initiative, provide numerous ICT resources to download. Some of the ICT and science courses, such as *IT Activities for Science 11–14* (Chapman and Lewis 1998) and *ICT Activities for Science 14–16* (Chapman et al. 1999), also provide step-by-step guides on how to use different types of software and hardware as well as differentiated activity sheets.

**Technical support**

Sustained problems with hardware or software can lead to a lack of staff confidence in its use and may deter staff from wanting to use it. Computers develop faults and ICT equipment needs to be updated from time to time. Without technical expertise or access to expertise, the use of ICT in the classroom could grind to a halt. In my school we are fortunate to have three full-time IT technicians to maintain our capabilities, but this has been a recent development. Sometimes the provider of the network or hardware provides the expertise, but access to this sort of help can be variable.

**How to train staff and develop ICT skills within the department**

ICT training should aim to give staff the skills for their needs. This should enable the teachers to implement the activities outlined in the schemes of work and ensure the targets in the development plan are met. There are distinct stages in this process, outlined in Table 1.3.

At my school we have found that external training sessions are useful to excite and supply information on new software and hardware, but general skills training can be done successfully as part of a regular INSET programme within the department. Skills training seems to be most successful when it is done at the time it is needed and using the equipment present within the department (‘just-in-time’ learning).
Health and safety

Health and safety issues related to IT equipment have received much coverage in the press over the past few years and there are several European Union directives regarding its use. Teachers have overall responsibility to ensure that IT equipment is used correctly and safely, to avoid eye strain, tendonitis, carpal tunnel syndrome, repetitive strain injury and even electrocution.

| Table 1.3 The stages in training staff in a science department |
|-----------------|----------------------------------|
| Stage | Action |
| A Identify the needs and competencies of the teachers | The skills of the teachers are assessed. This is normally done by questioning the teachers. I have found it is better to ask teachers not only if they can use a piece of software but also break it down to key skills with that software. |
| B Plan the training | The type of training received by the teachers is decided. The training may need to look at: |
| | • how the curriculum is developed; |
| | • how to improve the ICT skills of the teachers. |
| | The training can be delivered: |
| | • externally to harness expertise elsewhere; |
| | • on a school or departmental basis; |
| | • by self-study such as using an online training resource; |
| | • as part of a course such as NOF training. |
| C Carry out the training | The teacher undergoes the training session or course and uses it to help them implement their lessons or develop their curriculum planning. |
| D Evaluate the success of the training | The targets of the training such as the implementation of lessons, the effects on teaching and learning or the development of the curriculum need to be assessed (NCET 1994b). |
Review and evaluate your use of ICT

The use of ICT should be evaluated to see if the educational and curriculum targets have been met. It is important to evaluate use regularly and act on what you find. When I evaluate its use within our science department I try to ensure that any changes reflect:

- targets in the development plan;
- the introduction of new software and hardware;
- the best use of the current resources;
- the current competence of the science staff;
- changes in the ICT or science curriculum.

Recently, looking at the use of the Mimio and interactive whiteboards in the department, I realized that these pieces of equipment were having an impact on learning when they were being used, but they were generally underused. There were two main reasons for this: first, the staff had not had much training in their use; second, because of the way they are used they had not been fully written into schemes of work. Therefore, we are solving these problems and already this is having an impact. What is important is that the position is evaluated constantly.

It is difficult to evaluate targets such as the effects of ICT on learning. In previous studies we have used pre- and post-test strategies, pupil and teacher questionnaires, interviews, observations and value-added indicators. The easiest and most obvious piece of evidence would be the ICT and science grades reported at the end of Key Stage 3. The process of evaluation should also remove lessons that are unsuccessful and add others that incorporate any new software or hardware where appropriate. Teacher evaluation is still the primary method to assess ICT lessons in our department.

The future

It is important that ICT helps pupils to learn and provokes them to think about science and scientific concepts. We have had some success in linking ICT and critical thinking skills, a sort of ‘thinking ICT’ approach, and I see great potential in this area. Sometimes technology is used to support and enhance thinking skills lessons and sometimes thinking skills strategies are used to give structure to or ‘frame’ ICT lessons. We have used several different thinking skill strategies such as de Bono’s Six Hats (De Bono 1985), CASE and Concept mapping and cartoons to provide structure to lessons (McGuiness 1999). Related to this is the impact that ICT can have on science education outside the classroom. Pupils now have access to some high-quality science resources, such as simulations and revision material, at home and the teacher must be aware of the opportunities they
offer and try to harness them if possible. The speed of technological change continues, with the key software and hardware making huge strides every year. The present generation of Microsoft Office products allows voice recognition and it will be interesting to see whether this can impact on how pupils record activities such as science investigations. Science teachers need to concentrate on the educational value of the software and hardware. We have found that by using these tools in an innovative way we have been able to enhance our lessons while retaining the main focus on learning science.

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