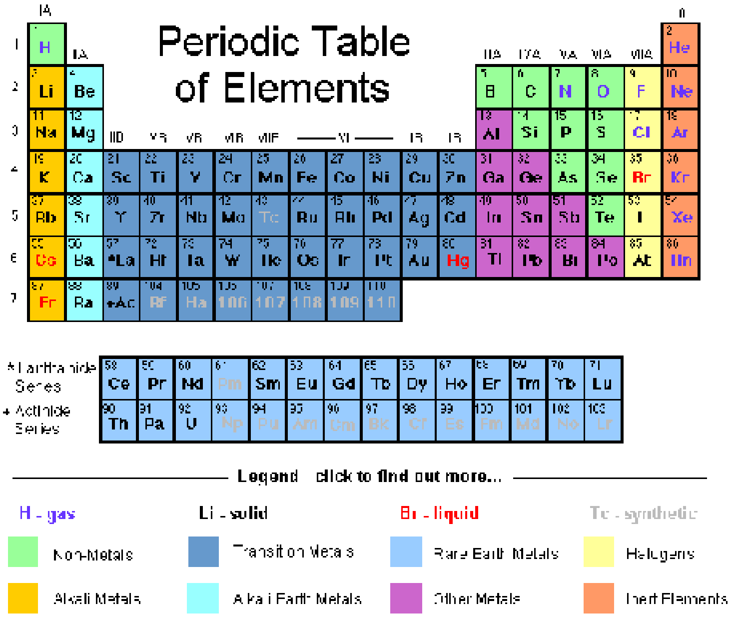
TALKING CHEMISTRY
Using correct scientific language



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Languages available
English, Slovenian

Summary
The use of scientific language and terminology enables scientists around the world to communicate effectively with each other. However, the use of scientific words and phrases is often confusing to non-specialists let alone non-scientists.

The aim of this activity is to introduce science students to reading and writing scientific papers and articles. Students read a scientific paper and convert the information into a form that non-scientists will understand. They convert information in the scientific paper into a 2-3 minute script to be read out on a local news channel.

Activity type B
Use of scientific knowledge and understanding to solve problems
Working in teams to solve problems
Communication

Techniques
Internet searching
Giving presentations

Field
Scientific Language
Chemistry Education

Time

Practical lessons:	135 minutes
Theory lessons:	45 minutes
Out of class time:	90 minutes

StandardBase procedures
None

StandardBase techniques
None

Other resources
These are listed in the text.

Student's document

TALKING CHEMISTRY: Using correct scientific language

Breaking news - 'Cervical cancer vaccine for girls aged 12. Girls as young as 12 could be vaccinated from next year against a virus that causes cervical cancer, the Government announced yesterday' (The Times, June 21 2007).

Science journalists need to be able to explain scientific concepts and technology in very clear language using words that non-scientists will easily understand. It is important that the journalist has a good understanding of scientific language to be able to do this correctly.

Your brief
As part of a team of researchers, writers and presenters for a local news program, you have been tasked with reporting on a recent scientific discovery. Working in your team, you must convert a recently published scientific article into a 2-3 minute script to be read out on the 6 o'clock news.

In this activity you will practice interpreting scientific language using Internet searches, dictionaries and any other relevant sources of information.

Your investigation
1. Collect or choose the article that you will report.
2. Start by reading it over quickly, then again more slowly.
3. In your group, discuss which words and terms you need to clarify.
4. Discuss how you might find the meaning of the unknown words or phrases.
5. Decide the most effective and efficient way of carrying out the work in your group.
6. Use scientific dictionaries, text books and the Internet.
7. You might find it helpful to search the web for articles on the same topic. The other articles may explain parts of the topic you are unsure of with language you understand.
8. Once you have carried out the necessary research, discuss your understanding of the article in your group and with your teacher.
9. Start putting together a script for your 2-3 minute news bulletin.
10. Decide who is going to present the report to the rest of the class. You may decide to project images or diagrams onto a screen to help clarify your report.
11. Practice reading out the bulletin and make sure it takes the right amount of time to read out.
12. The class will vote on who gives the clearest explanation of the article.

Your findings
1. Write a brief summary of your initial impression of the scientific article. How easy was it to understand? How much of it was written using scientific language?
2. Make a list of the words and phrases you had to look up and what you found out about each.
3. Write the method(s) you used to carry out this research.
4. How effective was each of the methods you used?
5. What advice would you give to other students about the best ways to find out about scientific language they don't understand?

6. After the research was carried out, how much clearer was your understanding of the text? Had you misunderstood any of the text to begin with?
7. Write up your script for the news report in a format that the presenter will be able to read easily.

Student self assessment
This activity is about using scientific knowledge and understanding to solve problems, working in teams to solve problems, and communication. For each case, write about 50-100 words explaining:

- what scientific skills and knowledge you used and how effectively you used them
- how you worked as a pair, giving examples of how you supported one another, and, if appropriate, worked with another pair
- what you learned about communication.

After completing the activity you should assess how well the activity helped you to develop skills. Fill in one version of the file: Evaluating skills.doc (available on the **ProBase** website). You should decide which version of the file is most appropriate for your course.

An example for assessing developed skills is also on **Student sheet**: *More sugary solutions for petroleum substitutes*.

Student sheet: Water's surface is acidic

Introduction

Below is an example of how to start and work on the activity. You will find the detailed procedure in **Your investigation**.

- First, an article was found on the web (location given) that serves as a text with scientific terms.
- Second, the terms are identified and grouped using a key, below.
- Then the meanings of terms are searched for and recorded.
- Finally, comprehension of the text is verified.

For example, after first reading it through, an analysis of the article is made. Starting from the beginning of the text we find terms about water.
- pure water
- neutral water
- water with acid skin

Mark them in *italics*, as you might be expected to know them (from chemistry courses and curricula).

Analysing the first sentence, there is a difference with what you will have learnt at school: *pure water* means no other compounds mixed in, and the pH = 7, which is *neutral*. There are minute concentrations (10^{-7} mol/dm^3) of each H_3O^+ and OH^- ions, besides H_2O molecules.

Now, the next sentences in the article explain the findings briefly, that just the *skin*, which means the surface of the water ("where water meets air at the surface"), is acidic. That means there are more H_3O^+ ions than OH^-.
The terms about pH are repeated later on.

In second and third paragraph, new terms appear. Some of them should be italicised, for example:
- trace gases
- rate of carbon dioxide absorption
- molecular biology
- hydrophobic
- proteins
- membrane structures

With the help of resources (if you don't immediately know the exact meaning), find their definitions. For example, for *trace gases*, a direct search using "trace gases" as a key word gives definitions (including gases like ozone, carbon dioxide, water vapour, nitrogen oxides, etc.) at:
http://en.wikipedia.org/wiki/Trace_gas
http://www.ace.mmu.ac.uk/eae/Atmosphere/Older/Trace_Gases.html

Next there comes *rate of CO_2 absorption*. Usually in chemistry, *rate* is used in connection with rate of reaction, speed of reaction (some quantity per time interval). However, note that absorption is a physical process. See the interesting comments on the nonsense usage "rate of speed" at:
http://physicsandphysicists.blogspot.com/2008/02/rate-of-speed.html
Web resources are used for the other terms listed.

Then there is a term to classify in **bold**:

- interface acidification

Here, use in the context of the third paragraph as a whole is suggested, but what could these terms really mean? Logic leads to the following reasoning:
interface: wherever the location, it means between faces. Here, the surfaces could specifically be a water surface or, alternatively, a protein or membrane surface.
acidification: this term could also be resolved in the context of the main point of the article, which is *acidic surface of water*. Using logic, it would mean *to make acidic*.
Now consider the system where interface acidification, that is, some kind of interference, is supposed to occur. Looking at proteins systems, proteins are structures made up of amino acids. As the name suggests, amino acids have a basic amino group (NH_2-) and acidic (-COOH) group. Thus, the text mentions acid-base chemistry, referring to changes that normally occur with amino and/or acidic groups.
Now, these changes would alter considerably in the case of an acidic water surface, as the third paragraph says.

In this way, other parts of the article can be analysed and the same method applied to the other **Student sheets**.

Key
Italics: scientific term that advanced level students might be expected to know
Bold: scientific term that advanced level students are not likely to know and, therefore, need to find the meaning
Underlined: not scientific words, but may cause problems for some people

http://www.rsc.org/chemistryworld/News/2007/April/26040702.asp

Pure, *neutral* water has an *acid* skin. This striking notion has now been confirmed by calculations and tests by an international team of scientists. Victoria Buch of the Hebrew University of Jerusalem in Israel and her co-workers have found that the *pH of pure water* falls from the perfectly *neutral value of 7* within the liquid to just 4.8 or less - about as *acidic* as beer - where water meets air at the surface.

The finding could be significant for a number of disciplines. In the atmosphere, many important chemical reactions between *trace* gases take place at the surface of water droplets in clouds. *'pH is an essential factor for many of these reactions*,*'* said Pavel Jungwirth, one of Buch's collaborators at the Academy of Sciences of the Czech Republic in Prague. 'The *low pH* could also affect the *rates of carbon dioxide absorption* at the ocean surface,' added water specialist Richard Saykally of the University of California at Berkeley, US.

And in *molecular biology* the effect might be reproduced where water comes into contact with *water-repelling* (*hydrophobic*) parts of *proteins*, changing the *acid-base chemistry* that goes on at *protein surfaces*. 'The effects of **interface acidification** on *protein* and *membrane structure* could be huge,' said theoretical chemist Gregory Voth at the University of Utah.

Water has an acid sting at its surface

Perfectly clear

It has become clear in the past several years that water's surface may look very different from the *bulk liquid*. Saykally and Jungwirth have shown that *dissolved ions* can become either depleted or concentrated at the surface. But the accumulation of *protonated water molecules* (H_3O^+ *or hydronium*, the basic component of acidity in water) at the air-water interface happens for unique reasons.

In 2004 Voth and his coworkers used **quantum-mechanical** computer simulations to show that *hydronium* prefers to sit at the water surface rather than deep inside the liquid. Whereas H_2O *molecules* typically form four *hydrogen bonds* to their neighbours, H_3O^+ can only form three. The three *hydrogens* can *bind* to other *water molecules*, but the *oxygen atom*, where most of the *positive charge resides*, can't any longer act as a good *'acceptor' for hydrogen bonds*. So, Voth's team said, *hydronium* acts somewhat like an **amphiphile** - a *molecule* with a *water-soluble* part and a *hydrophobic part*, like a *soap molecule*. The *ions* gather at the air-water interface with the *hydrogen atoms* pointing downwards to make *hydrogen bonds* and the *oxygen* pointing up out of the liquid. And in 2005 Saykally and his colleague Poul Petersen used a *spectroscopic technique* to get indirect evidence for this surface excess of *acidic hydronium ions*.

Getting fresh

Buch and colleagues now have fresh evidence. They have found that '*heavy*' *water* (D_2O) can swap its *deuterium atoms* for the *hydrogen in* H_2O about 20 times faster at the surface of ice **nanocrystals** (which have a liquid-like surface) than deeper inside. This switch depends on the presence of *hydronium ions*.

The researchers also have new simulation data for the surface acidification, which enables them to estimate the *pH* increase. But Voth cautions against placing too much weight on this number, because of the models' simplifications. For example, *'they have no possibility of having hydronium* (H_3O^+) *and hydroxide* (OH^-) *recombine*,' he said.

A key question now is whether the experimental evidence could be made more direct. 'We are thinking hard about how to do this,' says Saykally, 'but it's not easy.'

Philip Ball

Student sheet: Mild green ionic liquids

Key
Italics: scientific terms that advanced level students might be expected to know
Bold: scientific term that advanced level students are not likely to know and, therefore, need to find the meaning
Underlined: not scientific words, but may cause problems for some people

http://www.rsc.org/Publishing/ChemTech/Volume/2007/06/green_ionic_liquids.asp

Biodiesel production could become more *environmentally friendly* thanks to researchers in the UK who are using *non-toxic* **ionic liquids** to remove *unwanted by-products*.

The main by-product in the production of biodiesel from vegetable oils is *glycerol*. This *syrupy sugar alcohol* must be removed from the **biodiesel** as it can damage engines. Andrew Abbott and colleagues from the University of Leicester have developed a simple new approach to this sticky problem: they use green **ionic liquids** called **deep eutectic** *solvents* to just wash the *glycerol* out of the **biodiesel**.

Deep eutectic *solvents* are two or more substances mixed in a ratio that has a *melting point* much lower than any of the constituents. These are generally made from an **organic halide salt** that is *complexed* with something that will form a *hydrogen bond*. Abbott's team used **quaternary ammonium salts** *complexed* with **glycerol** as the washing liquid. This green washing liquid has many advantages including its low cost and toxicity; in fact, one *salt* used is **choline chloride - vitamin B_4.**

"The main by-product in the production of biodiesel from vegetable oils is glycerol."

This procedure not only has potential as a greener method of cleaning up biodiesel, but also as a method of producing pure glycerol. Alexei Lapkin of the University of Bath commented that the work 'is a very interesting development for **downstream** glycerol treatment and utilisation'.

Abbott hopes that 'further research will reveal a better method for recycling the *salt* and recovering the **glycerol**'. He added that the team want 'to collaborate with a biodiesel producer to test this technology on a practical scale'.
Wendy Crocker

Student sheet: Chemists arrive at the island of stability

Key *Italics: scientific terms that advanced level students might be expected to know* **Bold: scientific term that advanced level students are not likely to know and, therefore, need to find the meaning** Underlined: not scientific words, but may cause problems for some people

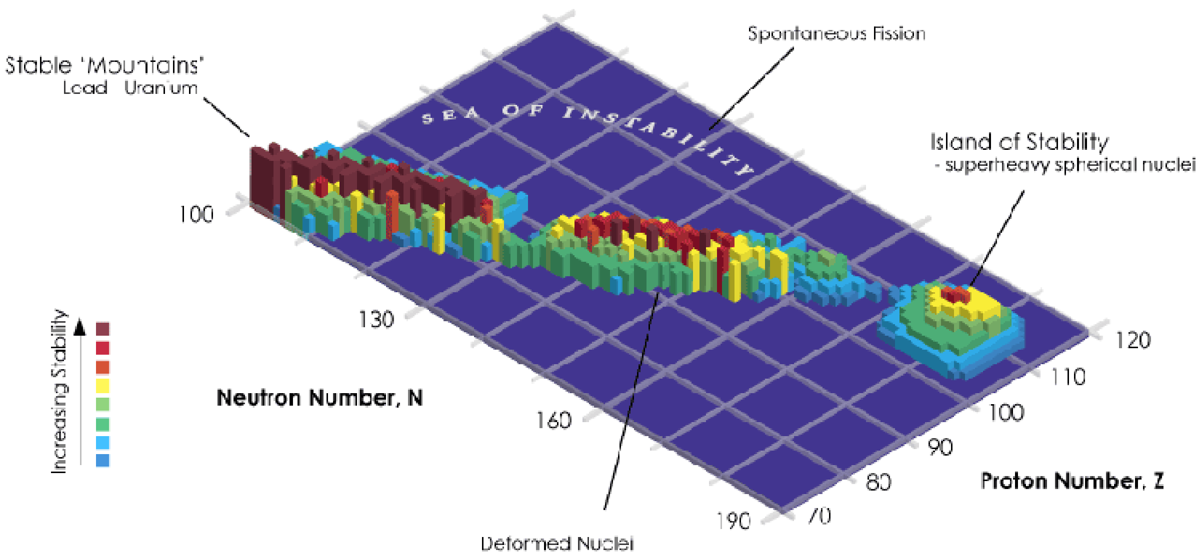
http://www.rsc.org/chemistryworld/News/2007/May/02050703.asp
02 May 2007

Despite predictions of exotic properties, '**superheavy**' *element* 112 behaves like one of the *family*, say **radiochemists** in Switzerland.

Robert Eichler, Heinz Gäggeler and colleagues at the Paul Scherrer Institute have confirmed the existence of **Ununbium** - as **element 112** is provisionally known - and shown it behaves like *mercury*, its closest neighbour on the *periodic table*.

Superheavy elements like 112 were first postulated in the 1960s to exist on an **'island of stability'**. Scientists soon set out in search of this idyllic-sounding spot, first looking for the element among **supernovas**. But the first sightings of 112 were made inside *particle accelerators*, by physicist Sigurd Hofmann and colleagues at the Institute for Heavy Ion Research (GSI) in Darmstadt, Germany, in 1996.

'The physicists provided no information on the *chemical properties* of 112 - only that it exists,' said Gäggeler. Theories predicting the behaviour of these elements were conflicting; the *high positive charge of a nucleus* packed with *protons* meant some of the *orbiting electrons* would be travelling close to the *speed of light*, affecting the *arrangement of electrons* around the *nucleus*. Would this make 112 a highly *unreactive element*, *inert* like a *noble gas*? Or would 112 behave more like *mercury*, the *element* it sits below in the *periodic table*?



The mysterious island of stability really does exist

'How do you design an experiment to disentangle whether **112** is *mercury*-like or gas-like?' said Gäggeler. 'We know *mercury* makes *very strong bonds* with other *metals*, including *gold*, to form **amalgams**.' So the team built a **detector array** made completely from *gold*, with a *temperature gradient* from +30 degrees to -180. In preliminary tests, *mercury* stuck to the very first detector, while the *noble gas radon* travelled almost to the last.

Eichler, Gäggeler and colleagues made 112 and tested its properties by firing a *calcium ion* beam at *plutonium*. On two occasions, this process gave complete *fusion* of the two *nuclei*, which *decayed* to give **112**. 'The two **112** atoms were detected only slightly below *mercury*,' said Gäggeler. 'So, surprisingly, **112** is just an ordinary *member* of the *group*,' he said.

Phantom element
'People were sceptical (of **112**'s discovery) until recently, as other labs couldn't confirm the results,' said Andreas Türler, who investigates **superheavy** *elements* at the Technical University Munich, Germany. 'Now, Eichler's results lend credibility to the discovery, and credibility that the **island of stability** does exist. Everybody is very excited, as now we can start to do some chemistry,' he said.

Yet officially, **element 112** still does not exist. Since Hofmann's first claims for the discovery of **element 112** in 1996, *IUPAC* (the International Union of Pure and Applied Chemistry) has been waiting for further results before confirming its discovery. 'I'm quite convinced *IUPAC c* will now recognize this *element*,' said Türler. 'This new chemistry doesn't have an influence on naming **112**, but the team could go on to name **114**. But having only seen two atoms, you can't really say **112** has been full *investigated chemically*!'

Paul Karol, who sits on a working group for *IUPAC* considering claims for the discovery of **superheavy** *elements*, declined to comment on Eichler's results. 'The competing claims for discovery of **112** are under critique by a joint group of "experts" right now and any revelation of our preliminary position would be most inappropriate,' he said.
James Mitchell Crow

Student sheet: Sweet substitute for petroleum products

Key
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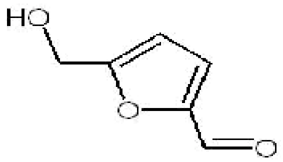
<u>Underlined: not scientific words, but may cause problems for some people</u>

http://www.rsc.org/chemistryworld/News/2007/June/14060702.asp
14 June 2007

Chemists in the US have developed a new way to turn the *sugars glucose* and **fructose** into a potentially useful *chemical feedstock*. The work reflects a <u>concerted global effort</u> to identify ways of converting plant-derived molecules, especially *cellulose*, into replacements for *petrochemical feedstocks* - the **biorefinery concept**.



Structure of hydroxymethylfurfural (HMF)

Haibo Zhao and colleagues at the Pacific Northwest National Laboratory in Richland, Washington, used *metal chlorides* in *ionic liquid solvents* of **the class 1-alkyl-3-methylimidazolium chloride** to *catalyse* the conversion of the sugars to 5-**hydroxymethylfurfural (HMF)**. HMF is widely viewed as a potentially versatile replacement for petroleum-derived <u>precursors</u> for a range of products. Current **HMF** production techniques rely on *acid catalysts* and are generally limited to **fructose**. *Acid catalysts* are problematic because **HMF** *decomposes* under *acidic conditions* to form **levulinic acid** and *formic acid*. **Levulinic acid** is especially difficult to *separate* from **HMF**, increasing production costs.

"The first step in our ultimate goal of developing a system to generate HMF from complex biomass such as cellulose"
Zhao's team found that, using their **ionic liquid system**, *chromium (II) chloride* was an effective *catalyst* for *converting glucose* to **HMF** with a *yield* of nearly 70 per cent and with negligible production of **levulinic acid**.

'Our method is <u>distinguished</u> from previous reports in that we observe high *yields* of **HMF** from **fructose** without added *acid*,' the research team reported in *Science*. 'Even more importantly, one of these *solvent-catalyst* systems is able to produce **HMF** in high yields from *glucose*, the first step in our ultimate goal of developing a system to generate **HMF** from complex *biomass* such as *cellulose*.' James Clark, who leads the Green Chemistry Centre at the University of York, UK, told *Chemistry World*, 'There is a definite need for more research effort <u>on low environmental footprint methodologies</u> for *converting biomass* into useful *chemical products and intermediates*.' However, warned Clark, the use of *ionic liquids* is a potential concern. '*Ionic liquids* are not really fully proven in the green arena,' he said.
Simon Hadlington

Student sheet: More sugary solutions for petroleum substitutes

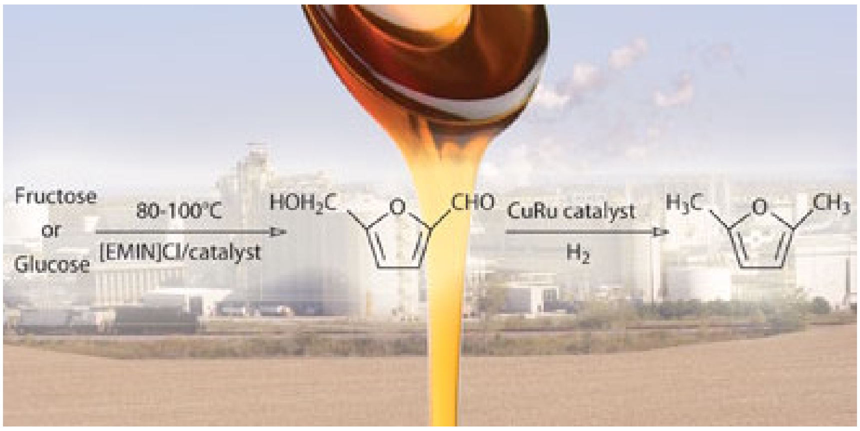
This example serves to be used as a follow-up activity to an analysis of the previous titles in **Student sheets**.

http://www.rsc.org/chemistryworld/News/2007/June/20060701.asp
20 June 2007

The global effort to develop new fuels and chemical feedstock from biomass - the so-called biorefinery concept - has been neatly illustrated by two independent research groups. These demonstrate how sugars can be catalytically converted to hydroxymethylfurfural, a possible intermediate for the production of plastics and other products that currently rely on petroleum, and dimethylfuran, which can be used as a fuel with a higher energy density than ethanol.

Haibo Zhao and colleagues from the Pacific Northwest National Laboratory in Richland, Washington, used metal chlorides in ionic liquid solvents to catalyse the conversion of both fructose and, significantly, glucose to 5-hydroxymethylfurfural (HMF), which has been suggested as a potentially versatile replacement for petroleum-based chemical feedstock. Current methods for producing HMF rely on acid catalysts and are generally limited to fructose. Furthermore, it is difficult and costly to separate the resulting HMF from its decomposition product, levulinic acid, which forms in acidic environments. The researchers showed that they could obtain exceptionally high yields with their method.

'Our method is distinguished from previous reports in that we observe high yields of HMF from fructose without added acid,' the research team reported. 'Even more importantly one of these solvent-catalyst systems is able to produce HMF in high yields from glucose, the first step in our ultimate goal of developing a system to generate HMF from complex biomass such as cellulose.'



From sugars to 2,5-dimethylfuran (DMF) via 5-hydroxymethylfurfural (HMF)
Meanwhile, Yuriy Román-Leshkov and colleagues[2] from the University of Wisconsin-Madison in the US have taken the process one step further by converting fructose-derived HMF to 2,5-dimethylfuran (DMF), a liquid whose energy density is some 40 per cent higher than that of ethanol, one of the principal non-petroleum fuel products produced from biomass.

Román-Leshkov's team used a biphasic reactor for the acid catalysed dehydration of fructose. This had the advantage of allowing a relatively efficient partitioning of HMF into an organic extraction phase while reducing unwanted side-reactions. The HMF is subsequently converted to DMF by adding hydrogen over a copper-ruthenium catalyst.

"The papers are very complementary"

James Dumesic, a member of the Wisconsin-Madison team, told *Chemistry World* that the work done by his group and the Washington team was complementary. 'Our paper shows very high selectivities for production of HMF from fructose, with a very inexpensive solvent system; however, our results show only moderate selectivities for HMF from glucose. Also, our paper shows how to convert HMF to a very promising fuel agent: dimethylfuran.

The interesting paper by Zhao shows rather high selectivities for HMF from fructose, using a specialised solvent; however, their results are very interesting for HMF production from glucose. Thus, the papers are very complementary.'

Commenting on the Wisconsin-Madison research, Lanny Schmidt and Paul Dauenhauer of the University of Minnesota said that the catalytic approach to converting sugars to DMF harnessed the 'best of both worlds' of conventional approaches: thermochemical techniques that involve heating biomass to partially oxidise it, followed by catalytic conversion of the products to form synthetic diesel, an energy-wasteful process; or the slow, inefficient method of fermentation of sugar to ethanol.

'Compared with existing methods, the benefits of DMF production are clear. Using fructose as the starting material avoids many of the energy-intensive procedures common to thermochemical techniques - for example the gas compression step that is necessary to recombine carbon monoxide into synthetic diesel,' write Schmidt and Dauenhauer in the journal *Nature*. 'By replacing biological processes, such as fermentation, with more conventional catalytic methods the conversion of sugar to fuel can be hundreds to thousands of times faster than before. This permits the use of much smaller refineries and could reduce capital investment.'

The authors add that the process 'will no doubt inspire many other combinations of chemical and biological reactions for biofuel production.'
Simon Hadlington

Teacher’s document

Overview

Scientific language is but one on Earth. Languages are numerous.

Students analyse the language in a recent scientific article and turn it into a 2-3 minute news bulletin for a local news programme. This is run as a competition with the winning group giving the most comprehensive report. This activity can be used to introduce students to reading and writing scientific papers. Students have to analyse a scientific article, looking at use of scientific language, how the style of writing differs from text they are used to and, perhaps, how they normally write up science reports.

The aim of this activity is to:

- develop students′ understanding of scientific texts
- develop their ability to find the meaning of terms they have not heard of before
- improve the way they write scientific reports

Developing students' skills

For students to improve their team working skills, you should allow students to work unassisted as much as possible. Encourage students to discuss amongst themselves how they will organise their workload, rather than asking you for constant feedback about the best way of planning the activity.
If students are unsure how to begin, you might suggest that they begin by electing a team leader who will chair discussions and make sure the work progresses according plan.

To check that students are using scientific knowledge to solve the problem, you might decide to ask the groups to report to you at key stages in the investigation. For example, find out the teams initial thoughts about the text after they have decided which words and phrases they need to research. Then check again after the teams have carried out their research.
If, at either stage, you feel that they are not going to meet the objectives of the task, you could give them some specific support and suggestions.

The development of students′ communication skills is assessed by the clarity of their news bulletin. It is useful to give students as much feedback as possible. For example, was the script good, but let down by the delivery? How did students′ understanding of the text affect their communication with the audience? Did they use correct language and terminology? Was this language appropriate for the audience?

Organising and managing the class

Choosing the article

Students need to study a text which, in terms of language, is out of their comfort zone, but is not beyond their understanding. For this reason, you may choose to select an article yourself instead of using the ones provided on the student sheets. You could choose an article covering a topic students are currently learning about, or one that is very current news. Journals such as New Scientist or Nature probably provide the right level of scientific terminology.

- **Places to find articles**

http://www.rsc.org/chemistryworld/
http://www.rsc.org/Education/EiC/
http://www.newscientist.com/home.ns

- **Websites about semantics in science**

http://www.google.si/search?hl=sl&client=firefox-a&rls=org.mozilla:en-US:official&hs=PvN&defl=en&q=define:Semantics&sa=X&oi=glossary_definition&ct=title
(Useful definitions of semantics, basic meaning of words, expressions and sentences.)
http://www.nwrel.org/msec/nwteacher/winter2004/barriers.html
("Words are labels for thoughts, ideas, concepts, and thinking" taken from web paper on learning maths and science.)

The importance of using language that is universally understood by all scientists no matter what their nationality or discipline is highlighted in this article about digging for data:
http://education.guardian.co.uk/elearning/story/0,,1682496,00.html

- **Websites about semantics in science for non-native English language speaking students**

http://www.ncela.gwu.edu/pubs/ncrcdsll/rr3/index.htm
(A research report: Ann S. Rosebery et al., *Appropriating Scientific Discourse: Findings from Language Minority Classrooms*, 1992)
http://wolfweb.unr.edu/homepage/crowther/ejse/torreszeidler.pdf
(A Study by Torres, Zeidler , *The Effects of English Language Proficiency and Scientific Reasoning Skills on the Acquisition of Science Content Knowledge by Hispanic English Language Learners and Native English Language Speaking Students*, 2002, with earth science, biology and chemistry 10 grade students.)

Organising groups
Since the activity is run as a competition, it is suggested you have a minimum of three groups with at least three students in each group.

The activity
Class discussion
Before arranging students into groups, you may like to discuss scientific language with the whole class. Perhaps discuss with students how they think research is reported both in the scientific community (in journals) and for the public. What are the difficulties of either approach? For example, journals are very inaccessible to non-scientists, while some media reports are so basic they can lead to misinterpretation of the facts.

The report below, on new methods for searching the web for scientific information, highlights the importance of scientists all using a common language. You might like to discuss this with your students.
http://education.guardian.co.uk/elearning/story/0,,1682496,00.html

Another issue worth discussing is that the language used in the media often leads the public to think scientific theories are proven facts. This gives rise to the

problem of the public becoming untrusting of scientists if theories are found to be wrong or if they are given conflicting reports. Who should they believe?
The difficulty is that, without understanding scientific language or the experiments carried out, it is difficult to judge the strength of the evidence for the claims made in an article.
Ask students how they think journalists might help to improve this problem.

Planning and researching
Students need to decide the best way to carry out the work. You should let them decide this independently, but the most sensible students will split the workload amongst their team.

Let students know what resources are available to them. They will need access to computers, the web, the library and, particularly, scientific dictionaries.

Before students write their bulletins, discuss with each group how much they have understood the text. This is to help students recognise the strengths and weaknesses in their understanding, and to rethink plans and ideas. It also gives the teacher an insight into the student's progress and, therefore, enables the teacher to give specific guidance and support.

When giving their presentations, students might request an overhead or data projector.

The class should vote on how clearly they understand each presentation, both in terms of the language used, and how well they think the group understood the topic discussed in the article. The winning group is announced at the end of the lesson.

Students should then complete their reports on the activity (see **Your findings** in the **Student's document**).

Session plan for teachers
Time depends very much on the students' language skills!
- Introducing the topic and checking prior knowledge; arranging students into groups (45 minutes)
- Preparation time for students to read the article, discuss, plan how to approach the task and allocate work (45 minutes)
- Time for researching scientific terminology and writing reports (90 minutes class time; extra time outside of lessons may also be needed)
- Giving presentations (45 minutes)
- Discussing results, drawing conclusions (45 minutes)

Technical notes

Preparation

If you do not wish to use the texts provided on the **Student sheets**, you will need to choose an article for the activity. You can use website sources listed under **Choosing the article** (see **Organising and managing the class**). Make sure you have definitions for any words that students may struggle with (you may wish to create a data sheet with these definitions).

Equipment and materials

- At least one computer per group with Internet access
- Scientific dictionaries
- Textbooks on the topic chosen for the article

TESTING PRIOR KNOWLEDGE

Select the correct answer

1. Which answer best describes the word Chemistry?
    a. Chemistry is about playing chess
    b. Chemistry is about chemises
    c. Chemistry is about chewing-gum
    d. Chemistry is about changes of matter

2. Which statement about Radon is false?
    a. Radon is a gas
    b. Radon is radioactive
    c. Radon is a name of the element
    d. Radon does not form compounds

3. Find the true statement about Table salt, Common salt, Edible salt, Rock salt, Sea salt.
    a. They are not all soluble in water
    b. They have nothing in common - these are totally different substances
    c. Their main ingredient, sodium chloride, is common to all of them
    d. Not all of them contain sodium chloride

4. Select the true answer. What does the term *salt* mean in chemistry?
    a. Salt is a compound that has salty taste
    b. Salt is a compound with ionic structure
    c. Salt is a stuff which comes in crystals
    d. Salt is the other name for sodium chloride

Note: Correct answers are given in red. These need to be removed before the test is used.

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