MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

These national newsletters are produced by the Secondary Student Achievement national facilitation team, as part of supplementary PLD support for schools, from the University of Auckland and Mau ki te Ako project partners (University of Canterbury, University of Otago and Ngāi Tahu).

National Newsletter: All Sciences including Agricultural and Horticultural Science

Information and resources for middle leaders in secondary schools | Term 4 2015

Tēnā koe, Greetings to you all, Kia orana, Fakaalofa lahi atu, Malo e lelei, Talofa lava, Talofa ni

Welcome to the Sciences newsletter for term 4, 2015. In this issue:

- Developing pedagogical content knowledge (PCK): Science as explanation
- Stories from schools on innovation with Science Capabilities and level 1
- Subject specific alerts

Science as explanation

Students need to develop understanding that science explanations are:

- Tentative, but evidence-based
- Subjective, because of human inference
- Developed by scientists who use creativity and imagination to interpret their observations and make inferences that are socially and culturally embedded
- Used by scientists to ultimately construct laws and theories to explain the world.

As human beings we have always tried to explain the world we live in, and we will continue to do so. Science is our way of seeking and using evidence to explain the physical phenomena we observe. Many teachers have not been aware of the key role of Science as explanation in developing Nature of Science understanding. A focus on the sharing of science facts does not always support students to produce their own explanations for what they observe, and link these to ideas from their science.

Bereiter and Scardamalia (2008) confirm that even Year 1 children can produce a whole range of "theories" in response to an observation or problem related to science. These students can understand the role of a "theory" is to explain. In the same way, older students need to be encouraged to begin to explain their observations and suggest links to science ideas they already have about the world. Teachers need to find out students' ideas and help to reframe them within a scientific context.

The challenge for teachers is to develop strategies that enable students to ask critical questions that can be explored through observation and measurement. Then students must be supported to use this information to construct their own scientific explanations backed by scientific evidence.

The matrix developed for Science as explanation can provide a useful tool for teachers to begin to provide students with feedback on their science explanations and support in developing the process:

http://goo.gl/HtaQ0V

Bereiter, C., and Scardamalia, M. (2008). "Teaching how science really works." *Education Canada*, *49*(1), pp. 14–17 .

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NoS elements of Science as explanation

One way to build student confidence in constructing their science explanations is to have them evaluate their explanations using ideas suggested in the Science Capabilities, such as:

Does the explanation make sense?
Do the suggested ideas relate well to the evidence/observations?
Do the explanations link to known science facts and observations?
Are there any gaps in the explanation?
Has any evidence been ignored?
Are there any other possible explanations?

Answering these questions supports students to understand that discovery of new techniques and information leads to changes to scientific knowledge over time, a key Nature of Science aspect for students to accept. Examples of changes in scientific thinking:

- Scientists commonly debate new information to arrive at new understandings. For example, recent developments in DNA technologies have resulted in the reclassification of some species.
- The status of Pluto as a planet in the solar system has changed.

Developing Science as explanation

Explanations of why a particular investigation or experiment is being carried out need to be given to students. The following learning experiences can develop students' ability to construct science explanations as they:

- Make comprehensive observations that include both qualitative and quantitative evidence by using ARB activity melting ice, Science Learning Hub activity floating eggs
- Think critically to construct testable questions
- Plan and carry out tests to collect evidence to address their questions Inquiry in Action resource from American Chemical Society
- Use this evidence to suggest explanations for their observations for example using ARB activity throwing balloons
- Compare their suggested explanations with existing science ideas and be prepared to reconsider their explanations in the light of new information, using ARB activity with concept cartoons rolling cars or Science Learning Hub activity great candle experiment.
- Explain why research needs to include controls and variables
- Explain why research conclusions are tentative – Tricky Tracks activity
- Discuss why peer review of research is necessary and why results from their investigation should be compared with other students' results and published data.

Stories from schools on innovation with Science Capabilities and level 2

Story 1 - Finding contexts to engage your students

A Chemistry teacher at a single sex boys' school selected the organic chemistry topic as the focus of her Teaching as Inquiry professional learning and development. Evidence from previous NCEA data showed that this externally assessed standard was least attempted by the boys she taught. After finding out the strengths and areas of need of her six target students, the teacher researched to ascertain the most effective ways to teach organic chemistry.

One particularly useful book was, 'Understanding Chemistry through Cars' by Bowers and Bowers. Repetition and pattern seeking were identified as effective tools, but the strategy highlighted in a number of readings was using engaging contexts for the different organic families. The teacher made laminated cards for each organic chemistry family and selected a context for each family, such as a property of the smell in new cars and condoms. The topic was introduced with the boys shuffling the cards around in their groups and reading about the organic chemistry associated with each organic family. This strategy has certainly engaged the boys and given a purpose for learning organic chemistry since they can now see how organic chemistry can manifest itself in the real world.

Important links and resources for science teachers

NZASE - New Zealand Association of Science Educators

NZASE is the professional body representing all Science educators.

NZASE has represented science teacher's interests in their involvement in:

- Developing guidelines on animal ethics for use in schools;
- Reviewing the Code of Practice approaches needed to address the revised legislation.

It is important for all schools to maintain their membership of NZASE in order to keep up with changes like these.

Membership includes access to the NZ Science Teacher Journal as a paper copy.

To register go to http://nzase.org.nz/membership/

Literacy and Numeracy page on NZQA site

There is a new Literacy and Numeracy landing page live on NZQA.

It was developed in order to have all of the information from NZQA and TKI sites accessible in one place.

This site is worth bookmarking for easy access.

http://www.nzqa.govt.nz/qualifications-standards/qualifications/ncea/subjects/literacy-and-numeracy/

Story 2 - Building context focused Biology investigations
The sole science teacher at a small Hawke's Bay kura wanted to get the Year 12 Biology class out looking at water quality in Maraetotara Stream at Te Awanga and Tukituki River at Red Bridge. The students carried out some field work in 2014 but had difficulty with collection of the data and writing meaningful conclusions.

This year the teacher persevered by finding Wai Care resources online which were used to help the students see why they were doing what they were. She also worked through several literacy activities to develop vocabulary use and writing processes with them.

In addition, the teacher contacted a scientist at the regional council who came with the students and showed them the fieldwork involved in her job as a scientist. This enthused the students – "Wow! That's what you do for a job? That's what we do for fun."

The scientist showed the students how to use NIWA's SHMAK kits and provided some data she had collected to compare with their own data. This year the students had improved success in data gathering, achieved the assessment, but they also showed a real understanding of the connection between flow rate and the macro-invertebrates found.

Story 3 - Student initiative on investigating environmental impacts of fertilisers
Two students from Northland College won the top young scientists prize for their project on protecting waterways at the Far North Science Fair. Kiani Pou and Nathan Tarawa investigated the best fertiliser to use that will cause minimal damage to the environment.

The pair analysed 72 soil samples from the school farm with various types and concentrations of fertiliser to see which had the lowest amount of phosphorus and leaching. Kiani had a vested interest in this research as this water runs onto her family's farm and any pollution would pollute her water too.

Phosphorus runoff from fertiliser enriches the water with nutrients which causes algal blooms. The decomposition of dead algae takes up all the oxygen and can harm eels, invertebrates and other freshwater organisms. They found the worst fertilisers for runoff are Superphosphate and then Serpentine Super as they had the highest amount of phosphorus and leaching. RPR (reactive phosphate rock) was the best fertiliser but farmers don't usually use it because it takes two years for the fertiliser to completely soak in. Normal fertilisers take between 2 and 5 months.

"It's not as good for the farm to grow their grass but it's better for the environment," they said.

"It was cool. I'm glad I did it. It's making me want to study soils."

Linking Teaching as Inquiry in science with school stories 1 and 2
The teaching inquiry uses strategies most likely to help students develop the understandings prioritised from exploring student needs. This uses information from the focusing inquiry and takes place during and after teaching, as teachers monitor and reflect on student progress.

Stories 1 and 2 show that by choosing teaching approaches that address science concepts that may be challenging for students (PCK), this can make a difference to student engagement and achievement. To this end, teachers may need to find out common student misconceptions and research approaches to address them. For example, students may not understand why knowledge of stream organisms or organic chemistry is important but these stories show that using a scientist or different teaching strategy can provide evidence of the theory and support learning.

Important links and resources for science teachers

The Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART)

ANZCCART was established in 1987 in response to particular concerns in both the wider and scientific communities about the use of animals in research and teaching.

Their main role is to provide leadership in developing community consensus on ethical, social and scientific issues relating to the use and wellbeing of animals in research and teaching.

ANZCCART has had assessment resources written and QAAM'd (a process where NZQA is paid to pre-moderate the assessment).

There are assessment tasks for Biology 1.2, 2.2 (1 task each).

Biology 3.2 (2 tasks) was due to be available by the end of week 8 in term 3.

COSMOS magazine

COSMOS magazine is providing lessons with an e-learning focus.

The magazine could be a useful source of ideas and approaches for teaching effectively for those at BYOD schools.

The resources will need some amending but they provide a good starting point.

Find out more at

https://cosmosmagazine.com/schools

Subject area alerts

NZQA documents
All subjects will have NZQA newsletters coming out in term 4. If you want notification of publication of these (or any other) documents being uploaded you need to join the NZQA Facebook page for your subject. To find these search Facebook e.g. "NZQA Biology"

There is some useful advice on assessment and assessment practices on the NZQA website that can be found on other parts of the website than the subject pages

- http://www.nzqa.govt.nz/providers-partners/assessment-and-moderation/assessment-of-standards/generic-resources/authenticity/ provides strategies and guidance about authenticity
- http://www.nzqa.govt.nz/providers-partners/assessment-and-moderation/assessment-of-standards/generic-resources/designing-assessment-activities/ provides information for teachers that might be considered when planning teaching, learning and assessment tasks
- http://www.nzqa.govt.nz/providers-partners/assessment-and-moderation/assessment-of-standards/generic-resources/assessment-tools-and-approaches/ provides a range of approaches that could be used effectively in science
- http://www.nzqa.govt.nz/providers-partners/assessment-and-moderation/assessment-of-standards/generic-resources/gathering-evidence-of-achievement/ provides advice relating to gathering evidence.

Digital tools: Unless specifically prohibited by the standard or Conditions of Assessment, students can use digital tools for assessment purposes where appropriate. For example, Excel (or a suitable graphing package) could be used when doing the graph and finding the trend in Physics 90935 (1.1). However, for Chemistry 91387 (3.1) the Conditions of Assessment state that pre-calibrated measuring equipment (such as data loggers) must not be used, so until such time as these Conditions of Assessment are reviewed this requirement must be adhered to when assessing this standard.

Physics
Physics 2.1 and 3.1 investigations
Two videos to support the teaching and learning of both achievement standards have been produced by Team Solutions (Simon Taylor). These include helpful tips on graphing and discussing non-linear relationships between variables in physics investigations, 2.1 (AS 91168) and 3.1 (AS 91521). Explanations of the different types of graphs and how they are transformed. https://www.youtube.com/watch?v=2twRLmCvVTg

They also include a simple and fun physics practical investigation of the non-linear relationship between distance travelled by a Barbie toy car and the time taken for it to roll down a ramp. Discussion of the control of variables, techniques to increase accuracy, limits and the physics ideas. https://www.youtube.com/watch?v=b6AA7HboyX8

Agricultural and Horticultural Science
Links to some useful teaching resources
http://www.nzsoils.org.nz/ Soils information - Level 1 and 2
http://goo.gl/AvzAme - Water quality information Level 2 and 3 (North Is)
http://goo.gl/hmKtyw - Water quality information Level 2 and 3(South Is)
http://goo.gl/6DdSLj Water quality conference findings 2010

Biology
Keep an eye out for notices about regional workshops for BEANZ members planned for term 4 in many regions.

Science online

http://scienceonline.tki.org.nz/New-resources-to-support-science-education

Remember to explore the materials on the Science Capabilities and Use of Digital Learning Technologies in Science.

For a source of useful NZ scientific research material ready to use to stimulate student thinking relating to the Nature of Science and the Science Capabilities go to:
http://www.allanwilsoncentre.ac.nz/massey/learning/departments/centres-research/allan-wilson-centre/our-research/resources/educational-resources.cfm

For a source of resources on a wide range of contexts and science stories including teaching ideas, reading resources and NZ scientific research material ready to use to stimulate student thinking relating to the Nature of Science and the Science Capabilities go to:
http://sciencelearn.org.nz/

The Science Learning Hub also offers on line professional development opportunities.

Secondary Student Achievement professional development

This newsletter is developed by the Science National Co-ordinators of the Secondary Student Achievement professional learning and development. Secondary Student Achievement is funded by the Ministry of Education and covers every learning area. Support is available to all middle leaders in the form of workshops, clusters and e-newsletters in every learning area and in a range of subjects.