*Science Education International*
Vol.21, No.2, June 2010, 92-101

International Council of Associations for Science Education

# Connecting teachers and students with science and scientists: The Science Learning Hub

Beverley Cooper, Bronwen Cowie, Alister Jones
*Faculty of Education, University of Waikato, New Zealand*

**Abstract**
*National and international data is raising concerns about levels of student interest and engagement in science in school and student retention into tertiary study. For today's students the Internet plays an important role as a source of information and means for communication with peers. This paper reports on a Ministry of Research Technology and Science funded initiative, managed through The University of Waikato, that aims to make New Zealand science research more accessible to New Zealand teachers and students. The New Zealand Science Learning Hub [SLH] illustrates how effective collaboration between research organisations, industries, science educators and teachers has enabled the development of a resource which is dynamic, up-to-date and relevant and that can be used to inform the teaching of science in New Zealand schools. The Science Learning Hub provides teachers with information about current research, which is related to concepts currently taught in year 5 - 10 classes (8-14 year olds). The site has content arranged in contexts for example, Icy ecosystems, Hidden taonga, Nanoscience, You me and UV, Future fuels, and The see through body. Each context includes text and images describing NZ research, video material such as interviews with scientists and sequences depicting scientists at work, teaching and learning materials, and links to science education literature. A feature is a "connections tool" which allows teachers and students to trace their journey through each context. Initial research indicates that teachers appreciate that this range of information is accessible in one place and has been quality assured. Students are keen to engage with and actively explore the range of media within the SLH contexts.*

**Key words:** Web resource, collaboration, contexts, student engagement

## Introduction

In New Zealand, as in other countries, a lack student engagement with science in the primary years and low student retention into tertiary study are a source of concern, all the more so given the crucial role of science in today's society. Data that indicates that student decisions to engage with science are highly dependent on the 'image' they

have of science and scientists (OECD, 2007) points to the need to reconsider their school experiences of learning. The tension between school science and science as portrayed in the media and the needs of potential science specialists compared to that of those in the workplace and as informed citizens (Millar & Osborne, 1998) means that addressing this situation is by no means a simple matter. In New Zealand, the Ministry of Research Science and Technology has responded to this situation by funding a web-based initiative, the *New Zealand Science Learning Hub* [SLH], to showcase New Zealand science and scientists with the ultimate aim of engaging students and teachers by providing ready access to recent New Zealand research in science. In this paper, we outline some of the issues around student engagement in science along with current shifts in thinking related science and science education describe the *New Zealand Science Learning Hub*, the processes involved in its development and its potential to impact on teaching and learning.

**New Zealand as a context for student science learning**

In New Zealand the number of year 8 (age 12) students with a negative view of science increased from 15 % in 1999 to 37% in 2007, as gauged by the National Monitoring Project (Crooks, Smith & Flockton, 2008). In contrast, the percentage of students saying they want to do more science at school has risen in both of the years surveyed - from 58% to 71% for year 4 students and 39% to 44% for year 8 students. Likewise, the percentage of students who want to learn more about science rose for year 4 students (up from 43% to 57%) although the proportion of year 8 students wishing to do this has remained essentially the same (33% to 34%). This pattern of interest in science was also evident in the TIMSS-2006/07 results which found that students in year 5 are generally positive about science with 84% agreeing that they enjoy learning science and 78% disagreeing that science was boring (Cargill, 2008). Boys and girls expressed similar attitudes to science,in terms of enjoyment and motivation and self-confidence. These findings suggest students are interested in science but they are not necessarily enjoying the science they experience at school. Complementing this work, a study by the New Zealand Ministry of Research Science and Technology indicates that the various factors influencing New Zealand students' decisions to study science in year 13 (their final year of secondary school) and beyond include personal interest, family background, positive learning experiences, and knowledge of potential careers (Hipkins & Bolstad, 2005). The ministry, in commissioning the survey, signalled a strong sector interest in engaging with teachers and students linked to the requirement for government funded research organisations to communicate to the public.

**New conceptions of science and science education**

In the revised *New Zealand Curriculum* [NZC] (Ministry of Education, 2007), due for implementation in 2010, the science learning area aims and objectives are organised in four contextual strands: Living world; Planet Earth and beyond; Physical world and Material world. The Nature of Science strand is the overarching, unifying strand. The NZC states that students need to explore how both the natural physical world and science itself work so that they can participate as critical, informed, and responsible citizens in a society in which science plays a significant role. That is, the science learning area places increased emphasis on student understanding the nature of science and how scientists work. The curriculum proposes that students need to appreciate

science as a socially valuable knowledge system, to learn how science ideas are communicated and to make links between scientific knowledge and everyday decisions and actions. This focus mirrors world wide trends which emphasise scientific literacy and or science for all (Aikenhead, 2005; Fensham, 2007). Alongside this, NZC has a strong focus on 21st century learning, and key competencies. The five key competencies aim to develop students to become confident and connected lifelong learners and citizens, who are able to make decisions that involve the evaluation and use of scientific knowledge and skills identified as: Thinking; Relating to others; Participating and contributing; Managing self; and Using language, symbols and text.

**Opportunities for engaging students with science**

Two areas of research have relevance for how we might put this expanded view of the goals of science education into practice in a manner that engages a diversity of students. The first is research that contributes to our changing understandings of how scientists work. Science is now recognised as a social activity that often involves cross-disciplinary work (Duschl, 2008). It is accepted that science knowledge and methods change overtime time and that scientists do not work in isolation from society. Moreover, they need to communicate their ideas effectively in the public domain for these to contribute community decision making. In the New Zealand context, consultation with local communities, primary industries and iwi is integral to the work of many scientists due to government science funding in NZ being outcome driven. To achieve these outcomes there must be benefit to end users to make a difference to society.

The second area of relevance to how we might engage students is that of our changing understandings of how students learn. Learning is now understood as an active process that involves the integration of cognitive, epistemic and social processes (Duschl, 2008). Teacher use of authentic contexts can support the integration of these domains. Indeed, the use of contextual activities is based on the notion that learning is more effective when ideas and information are presented within a framework that is familiar to the student (Souders & Prescott, 1999). The use of relevant, authentic contexts can provide a stimulus for dialogue, with a concomitant development and use of the language of science (Lemke, 2001; Roth, 2005). Contexts can foster curiosity and inquiry as a learning approach and as a learning outcome. They can enhance student confidence, interest and enjoyment, and provide opportunity for teacher and student creativity. Just as importantly contexts can assist students to see connections between science and their everyday lives. Contexts can help students appreciate the links between science and technology and society and enable students to engage with real issues and problems. An authentic curriculum, well connected to students' needs and interests, and to the world outside of school, can reduce student alienation and raise student participation and engagement (Venville, Wallace & Rennie, 2002). Contexts that use familiar, novel and socio-scientific issues to interest students, however, need to be carefully selected to ensure that the context is an integral part of the learning experience, rather than being used for illustrative purposes or for sparking interest at the beginning or end of a lesson sequence (Gilbert, 2006).

Information and communication technologies (ICT), particularly the Internet, offer new possibilities for engaging students with science through a combination of readily

accessible up to date and real life information and data presented in a range of modes including text, graphics, audio, and interactive objects. In New Zealand, a large national survey evaluating teacher use of government-funded personal laptops (Cowie, Jones, & Harlow, 2005) indicated that science teachers are enthusiastic users of Internet-based resources in their lessons to make links to student lives out of school and to illustrate ideas. Science teachers from case study schools reported extensive use of lesson materials that integrated text, simulations, interactive, and real-world data (images and video clips) to stimulate student interest and engagement. In addition, a disproportionate number of science and technology teachers assessed themselves as expert users when compared with teachers of other subjects. This said, the role of the teacher's pedagogical content knowledge, and particularly their 'specific knowledge of how *this* technology can be used with *these* students to accomplish *this* purpose' (Wallace, 2004, p. 450) was consider critical by teachers. As Wallace (2004) points out, teachers can face challenges when using the Internet. Some of the issues identified include setting boundaries for information gathering, establishing the trustworthiness of material, continuity of access to a particular website and lack of explicit pedagogy and disciplinary frameworks within the resources available online.

**Opportunities for teacher learning**

Research on how science teaching might be enhanced has highlighted the importance of teacher knowledge and its multifaceted nature (Jones & Cowie, in press; Shulman, 1987). The *New Zealand Curriculum* promotes school based curriculum development, which requires teachers to have breadth and depth of knowledge to discern the "science" in their local environment and tease out the pedagogical approaches appropriate to teach this to their students. A number of studies have found that many New Zealand teachers, especially those in the primary sector, lack the confidence to teach science because of their limited disciplinary and science education knowledge (Cowie, Jones & Harlow, 2003; Caygill, 2008). While New Zealand secondary school science teachers are required to hold a degree, which directly supports the teaching of science, this is not a requirement for primary teachers. Science at this time, as in countries elsewhere, is not accorded the same status as literacy and numeracy within the curriculum: literacy and numeracy must be formally assessed and reported on nationally in primary schools in New Zealand as from 2010.

Initial teacher education programmes provide a basis for teacher learning, as is further academic study. However, New Zealand primary school teacher education degree programmes are generalist programmes that prepare teachers across all curriculum learning areas. Alongside this, the challenge of finding contextual material for teaching science is amplified for all New Zealand teachers because there is no set text for science at any year level. Teachers are expected to design programmes by accessing and selecting from available texts and other sources such as the internet, magazines, teacher journals, newspapers, videos and television documentaries. Access to current information and research organisation expertise to assist in contextual teaching and to keep up to date with scientific developments can be difficult for teachers. Teachers can however extend their knowledge by sharing 'activities that work' (Appleton, 2003), observing other teachers and reflection on personal classroom experience (Grossman, 1990). The analysis of student work especially if undertaken in collaboration with other teachers is a rich source of teacher learning (Ball, 2000).

Well-designed curriculum materials can support the development of teacher knowledge through the way they represent concepts, tasks, procedures, and teaching approaches. (Ball & Cohen, 1996). Educative curriculum materials designed to address teacher learning as well as student learning have the potential to support teacher learning on a large scale (Ball & Cohen,1996).

The exponential increase in information available via the Internet, along with enhanced teacher access to the World Wide Web has implications for teacher learning, and how teachers might engage students with learning. New Zealand research indicates that teachers are keen to make greater use of the Internet and ICTs in classroom programmes. Alongside this, New Zealand students are active users of ICT technologies such as the Internet, computers, cell phones and iPods (Cowie, Jones et al., 2008). Science appears to be the learning area where many teachers consider ICT and Internet use has the greatest potential (Harlow & Cowie, in press). Nevertheless, as noted above, the design and implementation of activities using information and ideas sourced from the Internet is complex and time consuming and can test teachers' knowledge across a wide spectrum of expertise. The *New Zealand Science Learning Hub* website addresses many of these issues for teachers.

**The New Zealand Science Learning Hub (SLH)**

The *New Zealand Science Learning Hub* showcases New Zealand research as a basis for teaching with the ultimate goal of improving student and teacher engagement with science. Initially targeted for teachers of year 9 and 10 students (12-14 year olds) it has been expanded to meet the needs of teachers of year 6 students (9 year olds). The Hub was developed using a four phase approach that included searching for evidence of best practice, building on University of Waikato classroom based research (see for example Osborne & Freyberg, 1985; Cowie, Moreland, Jones & Otrel-Cass, 2008), seeking views from focus groups of representatives from key research organisations and industry, and the design of a comprehensive multimedia framework. The development team is comprised of three regional teams each lead by an experienced science educator. Each regional team consists of scientists, teachers, teacher educators and science education researchers. Each team works with research organisations and a subcontracted multimedia company to create material that draws on the interests of the key stakeholders, teachers, scientists and students. In this way the development team is able to capitalise on local expertise enhancing the likelihood that students from around NZ may find something of relevance and interest to them.

The SLH is organised into broad contexts designed to engage and interest adolescents such as ‘You me and UV’, the ‘See through body’, ‘Icy ecosystems’, ‘Hidden taonga’, ‘Nano materials’ and the ‘Sporting Edge’. Input from scientists from research organisations has ensured the authenticity, accuracy, relevance and currency of the contexts and expanded the traditional notions of what science is and what scientists do. Each context includes stories describing NZ research, video material such as interviews with scientists and sequences depicting scientists at work, teaching and learning materials, and links to science education literature. A feature is a “connections tool” which allows teachers and students to trace their journey through each context. Each context relates to strands within the science curriculum. For example, the Icy Ecosystem context presents information about Antarctica. Topics

within the context such as life in the Antarctic (i.e. marine and terrestrial ecosystems) and life in the Ross Sea (i.e. foodwebs and biodiversity) relate to curriculum achievement objectives in the Living world strand. Further topics include information about glaciers in Antarctica (i.e. density, continental drift) and on the issues involved in living and working in Antarctica (i.e. insulation) relating to curriculum achievement objectives from the Physical world and Planet Earth and also beyond the strands. This information is supported through research stories, or video material, which describe investigations New Zealand scientists are involved in and reasons for their involvement. This assists in illustrating and exploring aspects of the nature of science strand, which includes understanding about science, investigating, communicating, and participating and contributing in science. In addition the website provides teaching and learning support and activities that consist of textual material, multimedia (video clips, images and animations), as well as selected links to trusted external websites.

**Opportunities for research and evaluation**

The *New Zealand Science Learning Hub* illustrates how effective collaboration between research organisations, industries, science educators and teachers has enabled the development of a resource which is dynamic, up-to-date and relevant which can be used to inform the teaching of science in New Zealand schools. As part of the development of the Hub there are research and evaluation and quality control processes in place. An advisory group consisting of science educators who are expert in their fields plays a quality control role to ensure that contexts are coherent and information is accurate. Annually a visiting academic evaluates the work completed and provides critical feedback to inform the development of the SLH. The authors trial resources with teachers and students in schools and research is beginning to establish how the Hub is being used in classrooms to ensure that development is research informed. An early research study involving four teachers and 108 year 9 and 10 students (13 -14 year olds) focused on how teachers used the SLH to plan teaching units. The research indicated that students were keen to engage with and actively explore the SLH contexts. The students required an initial period to familiarise themselves with the SLH but from day two onwards students were synthesising the information on the website relevant to their selected inquiry questions. These inquiry processes were supported by the students working in groups. Students negotiated the meaning of and evaluated material before it was used to answer their questions (Otrel-Cass, Cowie & Fester, 2008). In another study, the students developed and investigated inquiry questions about Antarctica using the 'Icy Ecosystems' context (Otrel-Cass, Cowie & Fester, 2009). The students reported they liked using the Internet. They spent time alternating between watching the videos and reading the video transcripts and other text. These actions were accompanied by note taking. Students reported they enjoyed watching videos, but that text was better to go back to for research purposes. They overtly went through a process of organising and evaluating information, but their comments suggested what they attended to was shaped by their inquiry questions and their prior knowledge. Teacher guidance on how to use the organisational and informational features of the site along with the way teacher commentary to orient students towards the inquiry process and the site as a source of information was important. The research clearly showed, as with other teaching and learning materials, that lesson activities incorporating the SLH needed to have a clear purpose and structure and to be introduced at an appropriate pace if they

were to elicit active student participation. Added to this, research with students in initial teacher education programmes has shown that the SLH has the potential to enhance pre-service teachers' science content knowledge and understandings of the history and nature of science (Heap & France, 2009). This research also highlighted how the contexts could support pre-service teachers to consider current issues from multiple perspectives, to select content to support their point of view, and to interpret and critique data.

**Concluding comments**

International curriculum reforms have begun to expand the notion of what it means to study science by acknowledging the importance of the interactions between science, technology and society. The nature of science and scientific literacy demands for informed citizenship has moved beyond the knowledge base delivered in traditional school science programmes, although student understanding of science concepts remains important. Science education research has demonstrated the potentially positive effects of embedding concepts in carefully designed context-based programmes. The potential of Internet based resources to provide information that is readily accessible, locally relevant, up to date and in a variety of modes has advantages over conventional print media, but still needs careful design. The partnership between science organisations, science educators and scientists, arising from the New Zealand Ministry of Research Science and Technology funding of the Science Learning Hub, has provided an unique and exciting opportunity to develop web-based quality assured material that is engaging, authentic, current, and pedagogically rigorous.

While the initial emphasis in the SLH development has been developing a critical mass of material for teachers to use, the challenge now is to ensure teachers are aware of this resource and are supported to use the Hub as integral to their teaching. The Hub is publicized through teacher journals such as New Zealand Science Teacher and the Education Gazette. Hub writers present and run workshops at national conferences and teacher education institutions. Science advisers to schools are updated regularly on developments. As we develop and enhance connections with students, educators, research organisations and industry by providing interesting, current, curriculum relevant material in an easily accessible place, we expect the *New Zealand Science Learning Hub* to continue to make a difference to the way teachers and students approach and engage with science.

*The New Zealand Science Hub* www.**science**learn.org.nz

**References**

Aikenhead, G. (2005). *Science for everyday life: Evidence-based practice*. New York: Teachers College Press.

Appleton, K. (2003). How do beginning primary school teachers cope with science? Toward an understanding of science teaching in practice. *Research in Science Education*. 33, 1-25.

Ball, D.L. (2000). Bridging practices: Intertwining content and pedagogy in teaching

and learning to teach. *Journal of Teacher Education*, 51(3), 241-247.

Ball, D. L., & Cohen, D. K. (1996). Reform by the book: What is-or might be-the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher*, 25(9), 6-8,14.

Caygill, R. (2008). *Science - Trends in Year 5 science achievement 1994 to 2006*. Ministry of Education: Wellington, New Zealand.

Cowie, B., Moreland, J., Jones, A. & Otrel-Cass, K. (2008) *The Classroom InSiTE Project: Understanding classroom interactions to enhance teaching and learning in science and technology*. Teaching and Learning Research Initiative (Final Report). Hamilton, University of Waikato.

Cowie, B., Jones, A., & Harlow, A. (2005). The digital horizons: Laptops for teachers policy initiative: Impacts and consequences. *New Zealand Annual Review of Education*, 15, 111-132.

Cowie, B., Jones, A., Harlow, A., McGee, C., Cooper, B., Forret, M., Miller, T., & Gardiner, B. (2008). TELA: Laptops for teachers evaluation: Final Report Years 9-13. Report to Ministry of Education. www.educationcounts.govt.nz/publications, Ministry of Education Research Division.

Cowie, B., Jones, A. & Harlow, A. (2003). Primary and secondary teachers experiences of Science in the New Zealand Curriculum. *New Zealand Science Teacher*, 104, 29-34.

Crooks, T., Smith, J. & Flockton, L. (2008). National Education Monitoring Project: Science Assessment Results 2007. Educational Assessment Research Unit, University of Otago: Dunedin, New Zealand.

Duschl, R. (2008). Science education in three-part harmony: Balancing conceptual, epistemic, and social learning goals. *Review of Research in Education*, 32, 268-291.

Fensham, P. (2007). Policy issues for science education. Discussion paper prepared for World Conference on Science and Technology. Perth, Australia, 8-12 July.

Freyberg, P. & Osborne, R. (1985). Learning in science: The implications of children's science. Heinemann.

Gilbert, J. K. (2006). On the nature of 'context' in chemical education. International *Journal of Science Education*, 28(9), 957-976.

Grossman, P. (1990). *The making of a teacher: Teacher knowledge and teacher education*. New York: Teachers College Press.

Harlow, A. & Cowie, B. (in press) ICT in primary science: Insights from the TELA evaluation.

Heap, R. & France, B. (2009, July). *Contextualising NOS and NOT using a web-based resource*. Paper presented at the 40th annual ASERA conference, Geelong.

Hipkins, R. & Bolstad, R. (2005). *Staying in science: Students' participation in secondary education and on transition to tertiary studies.*Wellington: Report prepared for the Ministry of Research, Science and Technology.

Jones, A. & Cowie, B. (in press). Moving beyond deconstruction and reconstruction: Teacher knowledge-as-action.

Lemke, J. (2001). Articulating communities: Sociocultural perspectives on science education." *Journal of Research on Science Teaching, 38* (3), 296-316.

Millar, R. & Osborne, J. (Eds.). (1998). *Beyond 2000: Science education for the future*. London: King's College London.

Ministry of Education (2007). *The New Zealand Curriculum.* Wellington, New Zealand: Learning Media.

OECD (2007). *PISA 2006: Science competencies for tomorrow's world. Volume 1: Analysis*. OECD.

Osborne, R. & Freyberg, P. (1985). *Learning in science: The implications of children's science*. Heinemann: Auckland, New Zealand.

Otrel-Cass, K., Cowie, B. & Fester, V. (2009). Searching for the answer: The value of a custom designed science website. Paper presented at the Science Education Research Symposium, 19-20 November 2009, Christchurch.

Otrel-Cass, K., Cowie, B. & Fester, V. (2008). Early lessons from the use of the New Zealand Science Learning Hub website. Paper presented at the 39th annual ASERA Conference, Brisbane.

Roth, W-M. (2005). T*alking science: Language and learning in science classrooms*. Lanham: Rowman & Littlefield.

Schneider, R. & Krajcik, J. (2002). The role of educative curriculum materials. *Journal of Science Teacher Education*, 13(3), 221-245.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. Harvard Educational Review, 57, 1-22.

Souders, J & Prescott, C. (1999). A case for contextual learning. *High School Magazine*, 7, 38-43.

Venville, G., Wallace, J., Rennie, L. & Malone, J. (2002). Curriculum integration: Eroding the high ground of science as a school subject? *Studies in Science Education*,

37, 43-84.

Wallace, R. M. (2004). A framework for understanding teaching with the Internet. *American Educational Research Journal*, 41(2), 447-488