Expanding the context for student learning of science: the conceptual development of the New Zealand Science Learning Hub

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Abstract

Student engagement in science is an issue of international concern. Research indicates that one way to increase engagement in science is to involve students in authentic and relevant contexts that promote an enquiry-based stance. A key aspect to engaging students is to provide teachers with educative materials. In today's world teachers and students look to web-based materials for their own development and learning. This paper will provide a conceptual framework for the development of the New Zealand Science Learning Hub as well as describing the process of its development, its component parts and their relationship to the conceptual frame.

Introduction

The development of scientifically and technologically literate citizens has been almost universally welcomed as a desirable goal for education (e.g., Hodson, 2003). For this to happen, students need to see science as being relevant to life beyond the science classroom – both to engage in classroom learning, and because so little time is actually spent in classroom learning. As Lemke (2001) so eloquently puts it: "students' beliefs, attitudes, values, and personal identities – all of which are critical to their achievement in science learning – are formed along trajectories that pass only briefly through our classes" (p. 305). To help promote such a vision of science as relevant to everyday life, a range of approaches have been developed. These include context-based teaching and approaches advocated by the science-technology-society (STS) and socioscientific issues (SSI) movements. Within these, inquiry-based pedagogies are gaining traction in both the research literature and in emerging curricula (Etheredge & Rudnitsky, 2003). In addition, there is increasing research focusing on the affordances provided by information and communication technologies (ICT) in teaching and learning environments, including in science.

Here, we draw on the traditions of context-based teaching, STS, and SSI as vehicles to engage students in science learning and promote scientific literacy, as well as on literature related to the potential of ICT to support learning, to develop a conceptual framework for the New Zealand Science Learning Hub. This Hub (www.sciencelearn.org.nz) is an online portal funded by New Zealand's Ministry of Research, Science and Technology to make contemporary science research more accessible to school teachers and students in order to increase engagement and enhance learning. As will be explained, a sociocultural view of science and science education (Lemke, 2001) was used as the theoretical framework for the project. In particular, we focus on the role of the Internet as a mediating tool in the teaching and learning process. The aim is to enhance student engagement in science lessons and increase the perceived relevance of science, with the goal of increasing scientific literacy.

Science for all?

Contemporary society is significantly influenced by scientific and technological advances, and yet internationally students seem to be disenchanted with school science lessons. This is reinforced by large national surveys (e.g., American Association for the Advancement of Science [AAAS], 1989; Goodrum, Hackling, & Rennie, 2000; Millar & Osborne, 1998). A common concern is students' perceptions of the lack of relevance of science course content to their everyday lives. As Hodson (1998) reports: "Many students in science lessons are bored by content they consider irrelevant to their needs, interests and aspirations" (p. 5). Claxton (1992) is even more blunt:

> [The students] are told that what they are studying is a framework of understanding that is of unparalleled coherence, reliability and utility – yet in practice, for many of them, it boils down to a series of fragments that bears not at all on their own lives. (pp. 49-50)

In New Zealand, secondary analysis of international studies such as The International Mathematics and Science Study (TIMMS) and the Programme for International Student Assessment (PISA) suggests that initiatives that improve attitudes towards science could also help increase achievement (Baker & Jones, 2005). The impacts of student diversity are also significant, with NZ students showing far greater variance in PISA performance within schools than between schools, an above-average impact of socio-economic background, and a large proportion students (14%) at Level 1 or below (OECD, 2006).

Negative attitudes towards and lack of engagement in science education have of course raised concern with a range of stakeholder groups – science teachers, parents, the science community, and policy makers – placing the purposes of science education at the compulsory school level directly under the spotlight. Much of the discussion has focused on what Millar and Osborne (1998) describe as the "growing tension between school science and contemporary science as portrayed in the media, between the needs of future specialists and the needs of young people in the workplace and as informed citizens" (p. 4). These competing aims – of science for future scientists, and science for future citizens – have spawned an enormous number of projects and policy revisions internationally. Key to the discussion is 'scientific literacy', a term first coined in the 1950s as part of America's response to the Soviet launch of Sputnik and a need for public support for science, as well as parents' heightened awareness that their children needed to be receiving the kind of education that would enable them to cope in a society of increasing scientific and technological sophistication (Hurd, 1958, and Waterman, 1960; both cited in Laugksch, 2000). Since then, a large number of interpretations of scientific literacy have been developed. Here, we adopt Miller's (1983) definition in which scientific literacy is considered to have three dimensions: an understanding of the norms and methods of science (i.e., the nature of science), an understanding of key scientific terms and concepts (i.e., science content knowledge), and an understanding of the impact of science and technology on society. The assumption is that scientifically literate students will understand not only the concepts and processes of science, but that they also will see how this understanding is relevant to day-to-day life (Reiss, 2000). Such an emphasis provides opportunities in which to engage all students in science and its wider applications, potentially increasing students' motivation and enjoyment of science (e.g., George, 2006; Lee & Erdogan, 2007). In addition, by being more willing to engage in the relevant scientific and technological concepts and reworking them for use in specific contexts, students can potentially see how their science learning and understanding might help shape the world in which they live.

Internationally, curriculum reform reflects the shift from science education solely for training future scientists, to more broad notions of science education for responsible citizenship. For example, *Science for All Americans* (AAAS, 1989) spells out the knowledge, skills and attitudes all students in the United States should acquire as part of their total school experience in order to be scientifically literate. In the UK, *21st Century Science* is being piloted at the GCSE level (see http://www.21stcenturyscience.org) and *Science for Public Understanding* at the AS level (see http://www.scpub.org). Arguments for such reforms have been grouped by Laugksch (2000) into a macro and micro view. The former relates to benefits to society – that the economic well-being of a nation depends on its research and development programme (which requires not only skilled scientists, but a society willing to support and fund this work), and that increased scientific literacy may enable citizens to participate more meaningfully in public decision making and exercise their democratic rights more wisely. The micro view relates to the benefits of scientific literacy to individuals – that such citizens are able to negotiate their way more effectively in a science- and technology-dominated society and that they are more employable within so-called 'knowledge-based' economies. Gilbert (2001), reviewing the characteristics of knowledge likely to be valued in this type of economy, emphasises the need for flexibility, innovation, creativity, and risk taking; a breakdown of traditional subject boundaries; and a focus on knowledge developed by teams on an 'as-and-when-needed' basis. In her view, the content that is traditionally taught in science encapsulates 'old' knowledge not likely to be relevant or valued in the 'knowledge society' of the future. Duschl (2008) emphasises that "an understanding of criteria for evaluating knowledge claims, that is, deciding what counts, is as important as an understanding of conceptual frameworks for developing knowledge claims" and that "conceptual and epistemic learning should be concurrent in science classrooms … Moreover, they should reinforce each other, even mutually establish each other" (p. 278).

In keeping with international trends, curriculum reform efforts in New Zealand have broadened the scope of science education to include 'the nature of science' as an overarching and unifying strand through which students "learn what science is and how scientists work … build a foundation for understanding the world … and make links between scientific knowledge and everyday decisions and actions" (Ministry of Education, 2007, p. 28).

Context-based, STS, and SSI approaches

One pedagogical approach to address issues of disengagement and low scientific literacy is to teach science concepts using relevant contexts through which students can make links between their existing knowledge, classroom experiences, and the science to be learnt. For students already engaged in science learning, seeing the practical application of their learning can potentially lead to increased engagement. For students more disenchanted with traditional science learning, the use of contexts can potentially lead to engagement in learning about specific science and technology concepts and processes. In this way, notions of what it means to learn science, and the reasons for learning science, are expanded.

The concept of context-based science courses, designed to engage and motivate students by emphasising the relevance of science concepts to everyday life, began appearing in education literature in the 1980s. An assumption underpinning these developments appears to be that some students disengage from science because of the way teachers currently conceptualise science as the learning of a body of 'facts' and then structure their pedagogy to transmit these 'facts' as efficiently as they can without allowing for meaningful interaction between students and the ideas of science (Hipkins et al., 2002). In this sense, the word 'context' is well chosen, as Gilbert (2006) points out:

> The word originates from the Latin language in the verb 'contextere', 'to weave together'. In its related noun 'contextus', the word expresses 'coherence',

‘connection’, and/or ‘relationship’. Thus, the function of ‘context’ is to describe such circumstances that give meaning to words, phrases, and sentences. (p. 960)

As such, context-based teaching approaches emphasise the selection and use of appropriate real-life contexts in which to introduce particular science concepts in ways that are relevant to students and that allow for conceptual interconnections to be formed. Care must also be taken to ensure that the context is an integral part of the learning experience, rather than being used only for illustrative purposes or for sparking interest at the beginning or end of a lesson sequence (Gilbert, 2006; Jones, in press). Instead, embedding the concepts in the context potentially makes them more meaningful, ideally resulting in the construction of more coherent mental maps rather than the accumulation of isolated facts. The use of relevant, authentic contexts also provides a stimulus for dialogue, with a concomitant development and use of the language of science (Lemke, 2001; Roth, 2005) and may foster curiosity and inquiry as a learning approach and as a learning outcome. Although such programmes are diverse in nature (Gilbert, 2006) and surprisingly few empirical studies seem to have been conducted to test their effectiveness, students’ interest in and enjoyment of science lessons seems to increase when using context-based materials (Bennett, 2003; Bennett, Gräsel, Parchmann, & Waddington, 2005; Bennett, Hogarth, & Lubben, 2003). Such an approach also more closely resembles the process of scientific research than does collating a compendium of facts (Schwartz, 2006).

In New Zealand, the *Learning in Science Projects* (LISP) carried out over twenty years of research identified that effective pedagogical practice in science education includes the teaching and learning of science in contexts (Bell, 2005) and that this can have positive impacts on student learning (Jones & Kirk, 1990; Rodrigues, 1993). However, the research also raised questions about the short-lived nature of contexts considered by students and teachers to be meaningful and useful at the time. A national survey (Baker, 1999) also suggested that even though the science curriculum at the time (Ministry of Education, 1993) promoted the learning of science in context, teachers experienced difficulty in planning and implementing effective programmes and more than half of respondents (53%) felt that some students had difficulty coping with learning science ‘in context’.

Internationally, the STS (science-technology-society) movement has emphasised the teaching and learning of science concepts and scientific developments in cultural, economic, social, and political contexts (Bingle & Gaskell, 1994; Pedretti, 2005; Solomon & Aikenhead, 1994;). (STSE, or science-technology-society-environment, places significant emphasis on the environmental consequences of scientific and technological developments.) This movement was hugely influenced by the work of Peter Fensham, who believed that such an approach would enhance students’ understanding of the relevance of scientific discoveries, as well as enable them to engage with different viewpoints on issues concerning the impact of science and technology on everyday life (Fensham, 1985, 1988). This is considered important not only to engage students in science learning, but also to ultimately increase levels of scientific literacy in the general population.

Teaching approaches based on socioscientific issues (SSI) focus specifically on the controversial nature of many scientific and technological contexts. This presents opportunities for the moral and ethical issues associated with scientific and technological developments to be explicitly explored. Consequently, it has been argued that SSI “subsumes all that STS has to offer, while also considering the ethical dimensions of science, the moral reasoning of the child, and the emotional development of the student” (Zeidler, Walker, Ackett, & Simmons, 2002, p. 344). The recognition of the importance of incorporating socio-scientific issues in science education is reflected in the international trend in curricula to include specific statements of SSI.

In order for STS and SSI approaches to be effectively incorporated in classroom practice, the context as well as the relevant science concepts need to be carefully selected and (as with all effective teaching practice) appropriate attention accorded to the intended learning outcomes and assessment tasks. It is important to note, for example, that specific science concepts and/or skills are still needed in order for students to adequately explore selected contexts (e.g., Dawson & Schibeci, 2003; Keselman, Kaufman & Patel, 2004; Leighton & Bisanz, 2003; Lewis & Leach, 2006; Patronis, Potari, & Spiliotopoulou, 1999; Ratcliffe, 1997; Yang & Anderson, 2003). The scientific knowledge may also need to be re-worked and reorganised (Layton, Jenkins, MacGill, & Davey, 1993) and it is this process that potentially makes the learning more meaningful. The importance of content knowledge in students being able to construct quality arguments is less clear (Sadler, 2006).

Students' ability to engage in STS- and SSI-based learning depends also on their understanding of the nature of science (NOS). As Hodson (2009) argues: "Because SSI are often located in disputed frontier science (or science-in-the-making) rather than in established textbook science, knowledge and understanding *about* science is crucial" (p. 329). He goes on to point out that the interaction between students' NOS knowledge and the way they address SSI is complex and reflexive: "more sophisticated NOS views open up new possibilities for scrutinising SSI; engagement with important and personally significant SSI enhances and refines NOS understanding" (ibid.). Students' ideas about the nature of science, and how to develop them, should thus be carefully considered as part of an effective STS or SSI programme. For example, Ratcliffe et al. (2001) argue that as a result of their learning:

> Pupils should appreciate why much scientific knowledge, particularly that taught in school science, is well established and beyond reasonable doubt, and why other scientific knowledge is more open to legitimate doubt. It should also be explained that current scientific knowledge is the best we have but may be subject to change in the future, given new evidence or new interpretations of old evidence. (p.19)

The recently revised New Zealand Curriculum (Ministry of Education, 2007) brings many of these concepts together in 'The nature of science' as an overarching, unifying strand within science.

One way of ensuring the authenticity of contexts and expanding notions of what science is and what scientists do is to secure input from research organisations, and a range of approaches have been used to create links between such organisations and the classroom. These include providing classroom activities that illustrate laboratory processes (e.g., Sweeney, 1998); inviting teachers into laboratories and enabling them to translate the 'real process' into a form that they can carry out with students (e.g., Cullis, Sogor & Lachvayder, 1998); running programmes for school students in a university, science centre or R&D company (e.g., Joliffe, 2003; Thomas, Keirle, Griffith, Hughes, Hart, Schollar, 2002); and mentoring select groups of students (e.g., Chowning, 2002). Such initiatives tend to be expensive in time and personnel, however, and there may be additional logistical and health and safety constraints. They also require both teachers and the research community to develop and sustain an on-going relationship in order to develop embedded learning programmes rather than one-off learning episodes.

Alternative ways of accessing the research community include informal approaches by the teacher and students for information via relatives, friends and acquaintances; accessing mentors for the duration of an activity, where the mentor meets with a representative group charged with finding out specific information; or asking a representative to talk to the class about a specific activity or teach a specific skill (France, 1997). Information and communication technologies provide additional avenues by which teachers and students can access contemporary research (e.g., Linn, Clark, & Slotta, 2002).

The Internet as a teaching and learning resource

Information and communication technologies (ICT), including the Internet, have been recognised in the research literature for some time as offering significant educational potential. In particular, the mixing of text, graphics, audio, and interactive objects allows for multiple representations of content and customisation (Edelson, 2001) to create resources that are potentially relevant and motivational to a range of students (Ruthven, Hennessy, & Deaney, 2005). The authenticity and vivacity of non-textual media is seen as helping to stimulate pupil interest and engagement and the relative ease with which content can be updated means that information presented can be significantly more current than that available in textbooks. In spite of this, and ever-increasing student access to computers and the Internet at home and at school, a large government-funded study examining the impact of ICT on student attainment in the UK (Harrison, Comber, Fisher, Haw, Lewin, Lunzer, et al., 2003) suggests that the integration of networked technologies in subject teaching is just beginning.

In science education, a growing number of research reports suggest positive effects of specific software packages on student attitudes and/or conceptual development. There are also an increasing number of reports, in science education and other education literature, of the specific roles that the Internet might play in teaching and learning:

> As a source of information, the Internet can be used like books, library resources, or even a field trip. For representing content, it can be like a television, an overhead projector, or a laboratory. For communication, it may be like a visiting speaker. For collaboration, it can be used to organize small group work. (Wallace, 2004, p. 450)

Often, Internet-based tasks are incorporated into classroom programmes because teachers perceive them to increase students' enjoyment and promote more active participation (e.g., Cox, 1997; Ruthven et al., 2005; Wallace, 2004). However, where students have free access to the use of sophisticated technologies beyond school, any in-class motivational effects may be transient unless the task itself has authentic value (Sutherland, Facer, Furlong, & Furlong, 2000). The affordances, or opportunities provided for users in ICT-based learning environments, also depend not only on the resource but also on the activity in which it is used, and the nature of the classroom interactions (Webb, 2005). For example, the user-friendliness of an Internet-based resource, the specificity of worksheet tasks, and the classroom talk (both teacher-student and student-student) to clarify instructions and provide feedback can all potentially impact the affordance provided by the chosen resource. The role of the teacher's pedagogical content knowledge (pck), and particularly "specific knowledge of how *this* technology can be used with *these* students to accomplish *this* purpose" (Wallace, 2004, p. 450) is thus critical.

The incorporation of Internet-based activities in teaching and learning programmes may, however, challenge teachers in new ways. For example, Wallace (2004) points out that whereas with a textbook teachers can see what page students are on and what they are likely to be looking at, this is a lot more difficult to do when students are using a web-based environment: "Student work can be located anywhere in a nearly limitless information space, with the physical manifestation (what appears on the screen) varying with each page change" (p. 476). She goes on to discuss how, in this sense, the Internet inherently provides neither physical nor intellectual boundaries – although she does point out that "of course the boundaries offered by textbooks are also illusory, for what teachers really want to know is what is going in the students' minds" (p. 477). She also highlights the additional demands placed on the teacher's subject knowledge when students have open-ended assignments and look at sites teachers are not familiar with. (In contrast, van Zee and Minstrell, 1997, show positive gains in learning that come about when the authority for classroom conversations shifts from the teacher to the students.) Another concern is the lack of coherency of many web-based resources, particularly when they are not designed for educational purposes and therefore are not placed in a framework corresponding to the teacher's curricular needs. The relative stability (or instability) of web-based content can cause additional challenges:

> The very things that make the Internet desirable also lead to routine encounters with unfamiliar content: it is up-to-date, responsive to change, wide-ranging, and at the same time it is unreliable, unpredictable, and changing. For the teacher, this can mean dealing with new content at unexpected times and in unexpected ways. (Wallace, 2004, p. 472)

The design and management of the Science Learning Hub (SLH), described below, is intended to alleviate some of these challenges:

- the content is developed specifically for educational purposes, and presented in ways that are intended to give it coherence within an educational setting;
- quality assurance processes ensure the trustworthiness and credibility of content; and
- the security of long-term funding reduces concerns about stability and ongoing access to the content.

The New Zealand Science Learning Hub: A conceptual framework

Attempts to address issues of student engagement in science have included context-based teaching approaches and the incorporation of Internet-based learning activities, both of which can be considered within a sociocultural view of learning. This view was thus used to frame the development of the New Zealand Science Learning Hub, an online portal design to make contemporary science research more accessible to school teachers and students in order to increase engagement and enhance learning.

A sociocultural view of science and science education

Views of science have shifted since the 1950s away from a strictly empirical and positivist view in which scientific knowledge is seen to be universal, coherent, objective and unproblematic, towards recognising that it is sometimes uncertain and contentious, and that the beliefs and theoretical positions held by scientists determine the standards used to assess the adequacy of scientific explanations (Duschl, 1994; Hodson, 2003) particularly in what Kuhn (1962) described as 'revolutionary' periods of scientific investigation and progress. This highlights, as Duschl (2008) puts it, the "important role that models, mechanisms, and peers have in the advancement and refinement of scientific knowledge and the methods regarding the growth of scientific knowledge" (p. 272). Scientific knowledge therefore needs to be presented explicitly and implicitly as being personally and socially constructed (Driver, 1995), arising from group activity and collaboration that is often of a multidisciplinary and international nature where new knowledge claims need to survive a process of critical peer review in order to be accepted (Ratcliffe et al., 2001). The New Zealand Curriculum (Ministry of Education, 2007) picks up on this theme, going on to state that "Different cultures and periods of history have contributed to the development of science" (p. 28).

Science education, too, can be viewed as a sociocultural process in which knowledge is socially constructed and situated within its historical, cultural and institutional setting (Wertsch, 1991), emerging through social and cultural activity during community participation (Dalton & Tharp, 2002). This raises awareness of the complexity and impact of interactions between people, ideas, tools, and settings over time (Wertsch, 1998) and has direct relevance for pedagogical practice:

> Shifting the focus from knowing and reasoning by individual scientists or learners of science, to communities of scientists or learners of science, requires fundamental changes of both our images of science learning environments and of what we want students and teachers to do in those environments. (Duschl and Hamilton, 1998, p. 1054)

It also has implications for allocating importance to both the situated environment and the artefacts and tools in that environment. Thus, student activities in science need to be coherent and purposeful, situated in contexts that are meaningful to the learner and reflective of the kinds of problems that scientists might actually investigate (Hipkins et al., 2002). The multimodal nature of interactions around ideas and practices is also important. For example, *The Classroom InSiTE Project* (Cowie, Moreland, Jones, & Otrel-Cass, 2008) highlighted ways in which science teachers can provide multiple and multimodal opportunities for students to articulate, explore and refine their ideas, for example, through drawing, talking, writing, action as modelling, gesture and dramatisation, and the use and production of artefacts. These multimodal interactions enabled students and teachers to negotiate a shared understanding and presented opportunities for rich feedback and guidance. Artefacts such as handouts or visual aids acted to anchor or augment talk, and sometimes as an alternative. In a similar way, Internet-based resources such as the Science Learning Hub can act as a tool to mediate learning (Baggott La Velle, McFarlane, John, & Brawn, 2004).

Key components of the Science Learning Hub

The aim of the Science Learning Hub is to make the work of New Zealand scientists more accessible and relevant to New Zealand school students, showing how science is used by scientists and in the world and providing connections between science knowledge, the nature of science, and what New Zealand is doing in science. Thus, consistent with a sociocultural view of science, the nature of scientific work – as well as the conceptual and procedural aspects – is considered important, as are the personal narratives of the scientists and groups of scientists. Bicultural and multicultural elements are also given due consideration where it is relevant to do so, reflecting the nature of working in (and for) a diverse society.

Content is presented largely in the form of 'contexts', which form the dual purpose of reflecting the situated nature of science work, and providing a hook for the development of engaging classroom programmes. Each context explores a major theme or idea and is supported by a range of multimedia resources: examples of New Zealand research (multimedia representations of New Zealand's scientists and technologists in action); science concepts and ideas (explanations of the key concepts associated with each context); a question bank (supporting an inquiry approach to learning); teaching and learning approaches (a collection of classroom resources based on the requirements of the New Zealand science curriculum); and computer-mediated simulations and interactive activities. The interrelatedness of content is emphasised through an interactive 'connections' page, a visual tool linking content across the Hub, and an internal search engine provides an alternative strategy to locate related content. The classroom resources specifically reflect a sociocultural approach to science teaching and learning, suggesting ways in which the content can be incorporated with other aspects into a meaningful classroom programme. Examples of contexts currently available on the Hub are: See-through body (investigating medical imaging); hidden taonga (conserving New Zealand's unique insect ecosystems); sporting edge (applying science to improve sporting performance); H_2O on the go (the water cycle); space revealed; you, me and UV; enviro-imprints; future fuels; nanoscience; icy ecosystems; and earthquakes.

Affordances provided by using a web-based environment as the basis for the Science Learning Hub initiative include the layering of content to accommodate different educational needs, levels and interests; the multimodal nature of the content; and the ability to readily update content in response to the needs of both the education and science sectors. Initial research (Otrel-Cass, Cowie, Jones, & Fester, 2008) suggests that teachers and students may particularly value the credibility and trustworthiness of content, including links to other 'trusted' websites; the presence of a site-specific search engine; the multimodal nature of the content; and the 'one-stop shop' nature of the resource.

The development team is spread across regional teams based in three different locations, and subject quality assurance teams based at the University of Waikato. Each team is led by an experienced science education researcher and team members represent a unique blend of scientists, teachers, teacher educators, and science education researchers. The selection of contexts draws on the experience and professional knowledge of these teams and the extent to which proposed contexts suitably reflect contemporary New Zealand research, areas that are likely to be of interest to students, and the needs of the school curriculum. The developers then work with the scientists and a sub-contracted multimedia company to create content that best reflects the needs of key stakeholders – teachers, students, scientists, as well as the development team and the funding body. Key advantages of this approach include the synergies afforded when scientists and educators work together to develop resources that are accurate and up-to-date, as well as engaging and useful in the classroom setting; and the science sector being able to contribute scientific knowledge and expertise to education in ways that they can sustain.

As well as developing and maintaining the online content, the Science Learning Hub team is responsible for promoting the site with both the education and science communities, and working with select teachers as they use the resources with their classes. Research projects running in parallel with the project are intended to inform ongoing development.

Discussion and conclusion

Lack of student engagement in science is causing concern internationally, not only because of the need to sustain economic goals achieved through scientific research and development, but also to equip future citizens to participate fully and productively in democratic societies that are significantly influenced by scientific and technological advancements. Curriculum reform efforts have focused largely on the latter, expanding notions of what it means to study science and including references to the nature of science and notions of scientific literacy. Science education research has also contributed to these efforts. In addition, it has contributed to understandings of the potentially positive effects of carefully designed context-based programmes in which the teaching of concepts is embedded in contexts that students find meaningful and relevant. Within this tradition, both STS and SSI approaches have specifically focused on wider understandings of the nature of science, emphasising the interactions between science, technology, and society and the controversial nature of many scientific and technological endeavours respectively.

In education research more generally, increasing recognition of the sociocultural nature of learning has moved the focus from the cognitive structures of the individual learner to the situated nature of knowledge construction and the importance of the historical, cultural, and social-relational setting in which learning occurs as well as the artefacts and tools that form part of that setting. Not surprisingly, research on Internet-based resources as tools that mediate learning suggests that the affordances provided by a resource depend not only on the resource itself, but also on the task design and the accompanying classroom interactions. However, the Internet as a medium does provide several advantages that are more difficult to achieve with more conventional paper-based resources: content can be presented in a range of different modes; content can be more readily updated; a web-based environment can be used to connect different groups of people, blurring classroom-community boundaries; and new and different data collection, presentation, and analysis tools are possible. On the other hand, issues of stability, credibility, and the time taken to find resources of perceived educational value and/or to design appropriate learning tasks have in part limited the incorporation of Internet-based tasks in meaningful teaching and learning programmes.

In New Zealand, the Science Learning Hub is a government-funded initiative designed to increase student engagement in science using a web-based portal to connect school science to real world science in ways that are relevant to students and teachers and sustainable to the science community. Its design is intended to maximise the affordances that are possible when using a specifically-designed resource as part of an effective classroom programme. Key strengths are that:

- concepts are embedded in real-life contexts chosen because they both reflect New Zealand research and are likely to be of interest and relevance to students;
- contexts are presented in a multimodal format and layered to accommodate different educational needs, levels and interests;
- both the science and education communities have considerable input in the development of content, increasing its credibility and trustworthiness and making it educationally more meaningful;
- classroom resources provide practical solutions for New Zealand teachers based on the newly updated New Zealand curriculum; and
- content can be updated relatively easily in response to both the education and science communities.

Ongoing research is needed to guide future developments of the project, including how and why teachers use the resource and what the subsequent impacts are for student engagement and learning.

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