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A Study of a Crown Research Institute School Interaction: The Newstead Experience

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Report information sheet

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A study of a Crown Research Institute - School Interaction: The Newstead Experience.

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1. Introduction

The following study documents and describes an initial interaction involving the Rotorua-based Crown Research Institute (CRI) Scion, and the staff and students of Newstead Primary School in Hamilton, New Zealand. The interaction was part of a wider Ministry of Research, Science and Technology (MORST) science education initiative known as the Science-for-Life project, which has as its primary goals,

- To create positive experiences for students in science;
- To engage students in authentic and contextual research projects;
- To energise science teaching and develop best practice models.

(Scion, 2008)

The overall aim of the Science-for-Life project is to explore ways in which CRIs such as Scion are able to work with schools to promote interest in science, support teaching and learning in science, and extend broader goals related to general science literacy. Outcomes from the project include the development of a range of case studies illustrating approaches to how CRIs and schools are able to work together in achieving these goals, in order to inform the development of models of interactions able to be used across other CRIs and in school/industry partnerships generally. This study identifies the nature of the interaction, how it was negotiated, planned and implemented, what the significant outcomes were for the teacher and the students involved, and key messages to be carried forward in developing future interactions within the Science-for-Life project.

1.1. Case study methodology and data collection

A case study methodology was adopted for this research, as, according to Burns (1997), case studies can serve a number of purposes or functions within educational research. Due to their intense and subjective nature, he states that they are particularly suited to acting as preliminaries to major investigations by providing a "source of hypothesis for future research" (Burns, 1997, p. 365), or in assisting in developing deeper understandings "of the class of events from which the case has been drawn" (ibid. p. 366). As one of the primary purposes of the Science-for-Life project is to gather data related to how successful interactions can be achieved, undertaking a range of case studies exploring different forms of interaction in different contexts seems entirely appropriate, as they will reveal a range of experiences which can then be collectively analysed to identify common underpinning principles and activities. Consistent with qualitative studies of this nature, data were collected using multiple methods and tools.

1.1.1. Document analysis

A range of documentation related to the planning and development phases of this project was collected and analysed. These included:

- Statements and official documents from Scion related to the aims and scope of the Science-for-Life project, its purpose and philosophy, and where the project is positioned in terms of the CRI's contribution to wider 'public good' goals for science and science education;
- Planning documents from the participant teacher, which identified where and how the programme was to be integrated with the class curriculum and the national curriculum framework;
- A reflective log which was kept by the participant teacher for the duration of the project, in which thoughts and comments were recorded in relation to:

    a. The value of resources (human/equipment etc) provided as part of the interaction;
    b. The impact of the interaction on student learning, engagement, or interest in science;

c. The impact of the interaction on the teacher's professional practice in teaching science;
d. How the interaction contributed to the attainment of student learning outcomes;
e. Any impacts of the programme on the wider school community (eg: other teachers, school admin/management, parental/community interest or involvement etc);
f. What factors impacted upon the overall effectiveness of the interaction;
g. Ways in which the interaction could have been changed or improved (to inform future iterations);

- A Science-for-Life project Wiki which was setup in Wikispaces, and was used by both the teacher and students to showcase and communicate outcomes from the project, and gain feedback from key stakeholders (eg: parents, the principal, Scion staff, the researcher, and City Council staff);
- Other informal documentation such as emails and notes taken during meetings and other conversations.

1.1.2. Programme observation

During the course of the interaction, the researcher spent time with the teacher, the children, and Scion personnel as they interacted during the field component of the study, and in setting up supporting technologies. During this time photographic and video data was collected, and reflective notes taken, which was later analysed.

1.1.3. Semi formal interviews/recorded meetings

A total of three interviews were held with the participating teacher during the course of the study. The first of these was an interview related to identifying goals, objectives, and
expectations for participation in the programme and was held after initial coordination work had been carried out, but before commencement of the interaction itself. The second was a recorded meeting in which the researcher, the Science-for-Life programme manager from Scion, and the participating teacher, structured and integrated the interaction with longer-term teaching plans, making adjustments and refining goals and outcomes accordingly. The final interview took place at the end of the interaction and in the final week of the school term. This interview followed a predetermined schedule (Appendix 1) and sought to identify the participant teacher's views on the impact and effectiveness of the interaction, and possible ways in which the experience could have been improved. In all cases, interviews were transcribed and key messages extracted and recorded.

2. The research context

This study was conducted in a small (128) student semi-rural primary school on the outskirts of Hamilton, New Zealand, over a 10-week period, during the third term of the 2009 school year. The school has a decile[1] rating of 10, meaning that it is deemed to be located in an area at the top end of socioeconomic scale, and it draws students from both the surrounding rural area, and the nearby city. The school is surrounded by 'small block' farms and lifestyle properties, and is bordered by a natural gully and stream on one side, and rural farmland on the other.

[1] "A school's Decile indicates the extent to which it draws its students from low socio-economic communities. Decile 1 schools are the 10% of schools with the highest proportion of students from low socio-economic communities. Decile 10 schools are the 10% of schools with the lowest proportion of these students" (Ministry of Education, 2009)

The class selected for the study was a year 5/6 composite class comprising 13 boys and 15 girls, and being taught by a female teacher of 18 years experience. Approximately three hours dedicated topic time was allocated to the unit per week for the 10-week period, with additional hours being assigned (integrated) from scheduled literacy and language times, as the opportunity presented itself.

2.1. Research focus and questions

Data collection for this study sought to respond both to the wider goals of the Science-for-Life programme as introduced earlier, and more specifically, on detailing and describing the nature of the interaction, and the impact it had on both the teacher's practice and student learning. To achieve this, the following research questions were formed:

1. What was the nature of the interaction between the school and Scion, how was it developed, and how did it evolve?
2. What factors impacted upon the success of the interaction?
3. What key outcomes from the interaction can be carried forward to inform the design and development of future interactions?

While the above general questions underpinned primary data collection and were used as the basis While for interview schedules, reflective log specifications, and observational notes, additional questions and areas for inquiry were pursued where seen as relevant to the broader goals of the project, as previously described.

2.2. Data coding

Following analysis, common themes arose from the data in response to the research goals and questions, which have been used in forming the summaries below. These themes were:

- The negotiation of interactions;
- The nature of teacher planning and goal setting;
- Teacher pedagogy – specifically, the use of elements of Inquiry learning;
- The availability and use of technology;
- Knowledge development, the nature of science, and the importance of context.

Data across interviews, the teacher's reflective log, observational notes, planning documents and other communications (emails, Wiki etc) were examined, and comments/content relating to each of the themes were recorded, highlighted, or summarised, as appropriate. While the themes above have been listed as separate entities, in reality overlaps existed in the data where comments made and coded under one theme were sometimes linked to others. These relationships are explored in more detail in the following sections.

3. Findings

3.1. The negotiation of interactions

It was apparent from the outset of this project that any success was going to be highly contingent upon the degree of 'alignment of expectation' that could be achieved between the participating teacher (aka Helen) and Scion, and the extent to which what was agreed was adhered to. To help facilitate this, the initial negotiation around the topic and the input of stakeholders was collaboratively carried out, via a series of meetings, one held at Scion, and the other at Helen's school. The researcher, the Scion Science–for-Life project manager (Andy), and Helen, attended the meetings.

To help to develop a level of understanding of the CRI's work, it was considered beneficial for Helen to visit Scion and be shown the range of resources it had, and the research activities it was involved in. In addition, the opportunity was taken to develop an outline of the input Scion could have into Helen's intended unit on deforestation, and to negotiate variations on the theme to utilise more effectively Scion's resources, and the availability of local study contexts – in this case, the natural gully adjacent to Helen's school. To assist in this process, Scion had prepared and shared in advance a list of possible interaction 'types' and resources, which acted as a discussion starter and gave Helen an indication of the areas in which the CRI may be able to contribute. During the initial meeting, Helen presented a draft outline of her unit, and talked about her intention to focus on the development of questioning, higher order thinking, and Nature of Science/Living World/Planet Earth objectives from the revised New Zealand Curriculum Framework (Ministry of Education, 2007). She also mentioned her intention to focus on the curriculum Key Competencies of Thinking and Participating and Contributing (NZCF, p. 12), through her goal of involving students in a 'real' scientific investigation with an environmental and social focus (Helen, planning meeting, 6.00-6.30).

A valuable outcome of the planning meetings was undoubtedly the level of understanding that was developed by both the Andy and Helen about the 'ways of working' of the other party, and a greater level of clarity relating to the affordances and constraints around the interaction. This process was essential in order to develop a realistic level of expectation, and to avoid planning for interactions or support that were not possible. In addition, the joint meetings assisted Helen by helping her gain valuable science knowledge needed for her unit, and matching the curriculum objectives with the type of interventions and resources Scion was able to assist with,

> *…you see one of the things you could do here is to link your ecology one here (objective) - narrow that down into a biodiversity thing, in that forests provide certain things for us… and ecosystem services in that what do forests provide to society, to humans, that is beneficial… that is required… and we have a great series of resources for that… in our millennium goals…*
>
> *(Andy, 2009, 21.30 – 22.07)*

The meetings also dealt with the more logistical elements of the interaction, in terms of how the interactions were going to take place, and approximately where they were to be positioned within the unit. Such decisions needed to take into account the fact that the school was located over 100km away from Scion, effectively limiting the number of 'face to face' options available due to the time and cost of locating scientists 'on site', as needed. Therefore, in addition to limited site visits and assistance with practical components, the use of Information and Communication Technology (ICT) options to support the interaction, were explored in depth. These ranged from linking through audio and video conferencing, to the use of Skype and the development of collaborative online webspaces such as Wikis and Blogs. The use of such tools Helen viewed as particularly important, not only because they would add a new and previously unexplored dimension to her teaching, but also as they would support the integration of other curriculum areas such as literacy and language into the unit (Helen, 2009, 7.08 – 7.15). However, while the contribution of ICT was deemed to be valuable, both Helen and Andy agreed on the need to involve scientists directly in the project, working with the students in the school, exploring the gully and the ecosystem that exists there,

> *…it would be good… someone (a scientist) who could come into the gully… 'cause there has been some native planting, but there is a lot of... what's that weed… convolvulus… and it strangles the trees… it would be really useful if we had someone go through the gully with the kids… you know, these are natives, these are not natives, and what damage has been caused- 'cause the gully hasn't been managed properly… that would be really worthwhile… and even talking to the kids about basic things like 'how tress work'… you know, taking in CO2… I did some of that before, but I didn't know it all…*

(Helen, 2009, 35.50 – 36.36)

In addition to virtual and on-site contact, Helen indicated her keenness to use the interaction as a means of increasing her own science understanding, through being able to form relationships with Scion staff, and use them as 'sounding boards' to clarify her own science knowledge in areas of perceived deficiency. Her lack of depth and accuracy around the content aspects of the unit was a significant issue for her, and she felt that being able to access Scion personnel where needed to help 'fill the gaps' would give her greater confidence and security in addressing student inquiries. Both Andy and Helen agreed that on-site visits by scientists should concentrate on student 'hands on' practical science, while technology should be used for more question and answer or interview- type communication.

From the Scion perspective, as introduced earlier, the negotiation of interactions also represented an important learning opportunity for them. Although Scion staff had been involved earlier with a limited number of schools through the Digital Opportunities Forests of Life project[2], their knowledge of curriculum, school planning and assessment processes, and the constraints under which teachers operate, was not strong. Andy emphasised the reciprocal nature of the interaction, in that he hoped to gain access to Helen's planning, reflective journal, and other unit materials as they developed, so he could learn more about planning requirements and school processes to carry forward to subsequent projects,

> *…one of the things… I would love you to put your Word stuff up and I will get you a place to put it up (in an online collaborative space)… as you update your plan… as for me, that will be one of my learnings… the reciprocal nature of this… I am totally unaware of how planning happens in a school. One of the things I want to do from this is to develop these ideas a bit further, and put it all up in an LMS (online Learning Management System) so others can use it… we have a digital unit ready to go…*
>
> *(Andy, 2009, 53.05 - 53.53)*

In summary, the negotiated approach to the establishment and planning of the interaction was an essential element in the success of this case study. It served to clearly identify the practical and operational parameters of the interaction, the expectations and roles of each party, and mapped out a tentative timetable against which the progress of the interaction could progress.

3.2. The nature of teacher planning and goal setting

From the outset of this study, it was highly apparent that the way in which Helen viewed her role, and planned and designed learning experiences for her students, was pivotal to the success of the interaction. In many ways the timing of this interaction was opportune, as Helen had recently been involved in other professional development opportunities related to the development of differentiated curriculum, and was also involved with national professional development on the use of ICT in the classroom (ICTPD). In some ways, the availability of the interaction provided Helen with the opportunity to put into practice many of the more theoretical ideas she had learnt about in the 'Hooked on Thinking' differentiated curriculum planning initiative, and during her participation in the national ICTPD project.

The differentiated curriculum model Helen used was based on the SOLO Taxonomy (Biggs & Collis, 1982) which indexes student conceptual development through five stages, ranging from a basic level of information collection and gathering, through to the formation of generalisable and transferrable principles and ideas, able to be both abstracted and applied to multiple contexts. The thrust of the planning model is to provide teachers

[2] See http://www.digiops.org.nz/projects/currentprojects/forestsoflife/index.html for short description

with a structure through which they can support their students to progressively access and analyse more detailed and complex information, in the formation of broad conceptual understandings which can be turned into new knowledge and used across a range of different contexts and situations.

The planning model was closely aligned with an Inquiry learning approach, and identified specific developmental stages, the balance of teacher-student input at each stage, and the focus of anticipated learning (Figure 1). The unit was guided by a 'Driving Question', which was described as, "a catch all question or statement that will be the focus of the learning. This is developed from the concept, key conceptual understandings, context and achievement objectives" (Hooked on thinking, 2009, p. 2).

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Level of Autonomy in Student Knowledge Building
[Identify the students at each level] Place the names of the students in the class in the appropriate boxes (the boxes will grow!)

Stages in Student Knowledge Building	Formulating the Research Question.	Research: Locating relevant information.	Analysis of information and creating new knowledge	Presenting of new knowledge and understanding	Learning Outcome Emphasis
Supported	Teacher	Teacher	Teacher	Teacher	Content
Beginner	Teacher	Teacher	Student/Teacher	Student	Content
Proficient	Student/Teacher	Student/Teacher	Student	Student	Process
Expert	Student/Teacher	Student	Student	Student	Process
Autonomous	Student	Student	Student	Student	Create new knowledge

Figure 1: Stages of thinking outlined in the planning template

From this, Helen developed second level questions related to the specific focuses of the learning intentions, and based around the general themes of conservation, deforestation and consequences of decisions and actions (Figure 2). The final section of the planning format linked the focus and second-level questions back into specific classroom activities, which mapped out the progression of learning across the weeks of the unit, and included reference to specific learning resources, both digital (eg: YouTube) and personnel (eg: Scion) which would be used.

The use of the planning template and its seemingly 'natural fit' with the focus and intended outcomes of this project, also appeared to assist Helen in meeting broader goals related to the development of higher order thinking capabilities. She commented on several occasions that the science inquiry-base to the Science-for-Life initiative provided her with the ideal context to develop such skills, and meet her objectives under the Key Competencies of Thinking and Participating and Contributing,

> *…so our learning intentions relate to the different levels in the SOLO taxonomy, like... define the concept of deforestation is a uni-structural and a multi-structural concept… like defining… you need to be able to identify what the different parts of deforestation are… and talk about all the people and areas*
>
> *that have been affected by deforestation… well, that's multi-structural… compare and contrast our school gully in relation to Maungatautari… it's all in there… Key Competences, the lot...*
>
> *(Helen, interview 1, 2.00-2.38)*

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The Driving Question:	What if Questions:
[A catch all question or statement that will be the focus of the learning. This is developed from the concept, key concept understandings, context and achievement objectives.] What world will we wake up to tomorrow? te manu e kai ana te miro, nona te ngahere - te manu e kai ana te mataturanga - nona te ao What can we do today to create a better tomorrow **Three Subsidiary Questions:** *[Questions that help make sense of the concept across SOLO Taxonomy multistructural, relational and extended abstract learning outcomes*] **Question 1:** Multistructural LO's: Define, describe eg Describe how I can make a difference or Define conservation Define deforestation **Question 2:** Relational LO's: Sequence, Classify, Compare and contrast, Explain cause and or consequence, Analyse Explain cause and or consequence of a conservation action? Maungatauari **Question 3:** Extended abstract LO's: Generalise, Predict, Evaluate, Reflect, Create Predict the outcome if no action was taken? At Maungatauari and globally in reference to deforestation.	*[What if questions that help students explore the concept, contexts and achievement objectives identified through other perspectives, differences, alternatives, controversies, and disputes.]* These questions will be asked at the beginning of the unit and throughout to get the chn thinking. We will also add to these as we go. What if all the trees were cut down at Newstead? What if all the trees were cut down in NZ? What if all the trees were cut down in the world? What if you couldn't cut any trees down for any reason? What if you had to replant all areas that had trees cut down? What if there were no introduced predators in our forests?

Figure 2: The planning template indicating focus questions based on SOLO Taxonomy (Biggs & Collis, 1982)

There were also specific links to other curriculum areas, in particular literacy, where much reading group work was turned over to the Science-for-Life theme for the duration of the interaction. Helen commented that once again the topic lent itself to natural integration, in that students were able to develop their reading and research skills while 'acting like scientists' in developing responses to project questions and inquiries. This involved not only accessing and processing digital information, but also information from more traditional sources,

> *...we're doing a lot of science – in reading we decided to do non-fiction text, so we've been looking at a lot of articles – journals – we would look up articles that would be related to conservation of the bush… everything's there… and when they're using the laptops (internet) they're reading all the time and they don't even know it…*
>
> *(Helen, interview transcript, p. 7)*

The final written plan was developed by Helen, but the process of developing the ideas for content and activities was a collaborative process involving Helen, Andy, and the researcher. It was considered that by adopting this three-way strategy at the planning stage, it was likely that greater alignment would be achieved between the capabilities of Scion to support the unit, and the needs and desires of the teacher. There was an acute awareness by both parties not to 'over promise' what was possible, and to keep the interaction manageable but worthwhile.

While the initial plan provided a structure within which the interaction could be developed, and mapped out general learning activities, it was apparent from early in the unit that significant flexibility was needed in order to accommodate the interests and questions of the students, and also to match the resources and capabilities of the Scion personnel. While this was not seen as an issue, it did cause the main focus of the topic to change somewhat as the unit developed, as Helen describes,

> *…we did decide to do the whole school focus on conservation… so we decided to look at gullies… it's changed as we have gone along. We have ended up doing a big focus on pests and predators, focusing particularly in our gully and the effect they have on the ecosystem and plant life and animals…*
>
> *(Helen, interview transcript, 2009, p. 1)*

The change from the original focus on deforestation was undoubtedly supported by Helen's responsiveness to the interests of her class, and the questions they posed. It was also evident that the fact that she had the support of the Scion link, both in terms of resource and personnel availability, gave her *more options* for different learning experiences than she would have had before. As she commented, "it's much safer to stay in the classroom, and get out our books, it's easier to do it that way" (Helen, interview transcript, 2009, p. 4), but in terms of student outcomes the benefits of "real life, real science experiences" (ibid, p. 2) far outweighed any managerial or logistical issues. Although this project moved her significantly out of her comfort zone, she considered this was a valuable experience in terms of her own professional journey with both science and Inquiry-based learning.

3.3. Teacher pedagogy and Inquiry learning

As previously mentioned, while the interaction was well-planned and structured, there was also built in considerable responsiveness to the interests of the students, and the nature of support available from Scion. For Helen, the departure from her traditional approach to teaching which tended to follow a more predetermined (and teacher directed) sequence presented new challenges, and opportunities. By her own admission, the Science-for-Life project and its Inquiry base prompted her into rethinking her pedagogy to take the best advantage of learning opportunities *as and when they arose,* even if this meant 'missing out' on pre-planned activities in other curriculum areas in order to capitalise upon the interests and questions posed by the students.

While initially a little uncomfortable about this, the fact that student enthusiasm and interest was so high (and enduring), the context of the study was local and available, and the Scion connection consistently served as a source of new ideas, knowledge and resources, meant that Helen could have confidence in pursuing new and varied lines of inquiry, as they came on-stream,

> *…normally I'm much more structured… I'm going to do this… then that… a lot more things planned ahead. I suppose I've relaxed a bit and let things flow a bit more. It's worked particularly well because of all the contacts we've had (Scion), and the gully, which is local…*
>
> *(Helen, interview transcript, 2009, p. 6)*

The willingness of Helen to responsively adapt her planning was, as she describes “a big learning curve” (ibid, p. 4), but one which she saw as being extremely valuable in maximising the benefits of the interaction, and allowing her students greater levels of ownership and direction of their learning. This move towards an Inquiry model effectively meant that much of her planning was completed as she went or retrospectively, because it was not entirely possible to accurately predict and plan an intended learning pathway,

> *…I have allowed a lot of the learning to be directed by the kids and what they are interested in, and then what’s been available – so I’ve constantly had to add to my planning, and it has changed and evolved. Things I planned to do weeks ago, just haven’t happened because we have done all this other stuff instead.*
>
> *(Helen, interview transcript, 2009, p. 4).*

The key to the success of this approach appeared to be linked to Helen’s ability to keep a firm focus on her intended learning goals and outcomes, while at the same time allow her students higher levels of input into how these were achieved. This pedagogical strategy is consistent with teachers using Inquiry learning models, and while the transition to this approach for many teachers represents a significant (and often uncomfortable) departure from more traditional pedagogies, in this case Helen’s willingness to vest greater levels of learning responsibility in her students was pivotal to the success of the interaction,

> *…we did have our outcomes; what we wanted to get out of this, and keeping that in mind… we’ve also said ‘that would work really well, let’s do that’ or a child would suggest something or ask a question and we’d say… ‘that’s a good idea, let’s do that’. I used to get locked in to the amount of time we had, and then have to stop, whereas with this, it doesn’t matter if it’s taking a bit longer…*
>
> *(Helen, interview transcript, 2009, p. 7).*

The adoption of an Inquiry model for this interaction also impacted very positively on student engagement and motivation. While, according to Helen, topic-based units were normally of two to three weeks in duration, this topic had lasted a term (10 weeks), with student interest showing no signs of dissipating. Helen commented that the fact that student inquiry led the unit throughout, increased the relevance and authenticity of learning, and meant that there was a constant stream of new ideas upon which to build learning experiences. The challenge for Helen in this respect was to ensure that the students’ ideas were validated, while at the same time contributing in some way towards her broader goals for the unit. She appeared, on occasions, to ‘wrestle’ with how best this could be achieved, as often student questions and ideas, while being interesting and worthy areas for inquiry, were not compatible with the overall goals she set for the interaction. She appeared to reconcile this through her willingness to take risks, and while she acknowledged that such an approach was not compatible with all areas of learning, insofar as this interaction was concerned, she felt secure in being able to do this due to the level of support she received from Scion, and the resources at her disposal,

> *…the motivation, excitement… the questions were great. Deciding on the next step, who we can find out from, who we can write to, working it all out. It’s the whole Inquiry model… but you need to be flexible and prepared to go in multiple directions, and as a teacher, be willing to drop what I’m doing and be prepared to do something else, and take risks… huge risk taking for me personally as a teacher… but having them (Scion) there was fantastic… there was always someone to ask…*
>
> *(Helen, interview transcript, 2009, p. 9).*

In many ways the success of this interaction was more related to Helen’s ‘way of thinking’ or teaching philosophy, than it was to any particular teaching or planning model. The adoption of an Inquiry approach, underpinned by a planning model dependent upon the use of students' questions and focusing on higher order thinking skills, were only able to be operationalised because Helen was willing to take risks and try something new. That is, the successful implementation of Inquiry models requires teachers to view learning and how it happens quite differently from more traditional teacher-centred approaches, and this cannot be facilitated through the advent of Inquiry planning templates or higher order thinking models, by themselves. Resources such as these merely provide teachers with a visible framework to record their thinking – they cannot stimulate changes in practice.

3.4. The availability and use of technology

An integral component of this interaction from the outset was Helen's use of ICT in almost every aspect of the unit. As mentioned previously, while ICT was used to bring to the classroom 'expert knowledge' from the Scion staff, it was also used extensively within the student-led inquiries, and for communicating outcomes to parents and other stakeholders as they developed. There were three key elements to the valuable contribution ICT made in this unit. Firstly, a resource kit comprising four laptop computers, four digital microscopes, a night vision camera, and three digital cameras was provided to the class by Scion for the duration of the unit. The access to additional computers (to compliment the two older classroom computers), meant that Helen was able to involve her whole class in groups as they went about their inquiries using the Internet, or analyse, using the digital microscopes, soil samples or other specimens found in the gully (Figure 3).

Figure 3: Students using the digital microscopes and laptops provided by Scion

Having access to technology sufficient for the whole class also opened up a whole new array of information sources which could be built into her unit in a structured way, or in response to student-led inquiries. Where there was a need for all students to acquire specific objective-related knowledge, Helen would source suitable websites and install them on the class Wiki along with focus questions to direct student note taking. When student questions prompted lines of inquiry not originally planned for, Helen would encourage the students to identify keywords that could be used as search terms, and then model a range of search strategies using Google (and other search engines) using the data projector, before allowing the groups to undertake independent investigations,

…having access to the laptops was brilliant. I could have all the children in groups on a computer, answering specific questions, which these websites were linked to (the Wiki)… so it was quite directive in some places... but they were still making their own notes. It was great… there was no point in going down to the gully and putting food in the traps when we didn't know what the predators liked to eat! I couldn't have done it without the technology, a lot of it, and having the night camera and being able to get real footage… that was huge.

(Helen, interview transcript, 2009, p. 2)

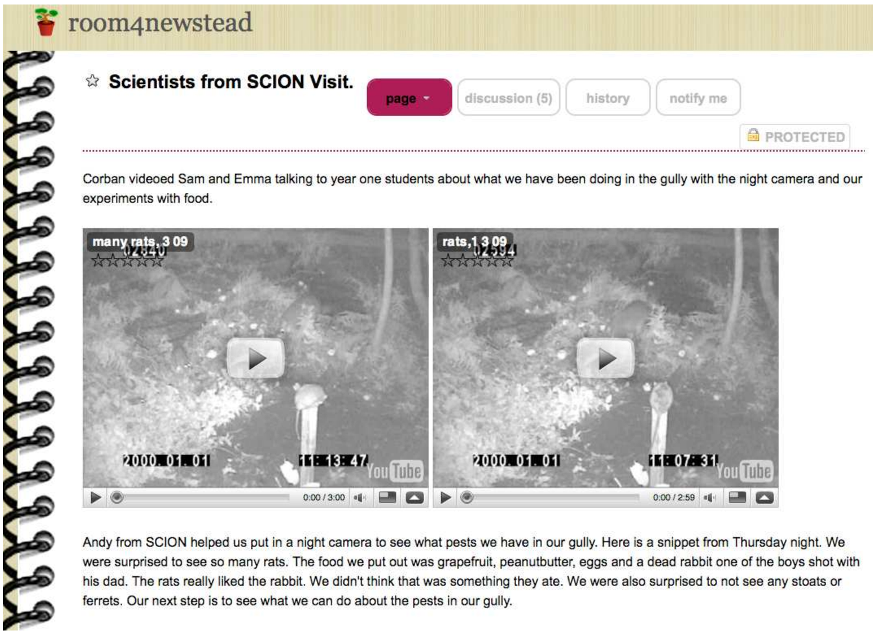

Figure 4: The project Wiki on Wikispaces showing footage gathered by the night vision camera

The second significant contribution ICT made to this project was its use in communicating and sharing project outcomes with diverse audiences, and the impact this had on students' engagement in literacy-related activities such as procedural writing and reading. For the duration of the project, Helen established a class Wiki on Wikispaces (Figure 4), which was used to report project findings and invite contributions and comments from others, particularly parents and those involved in similar initiatives. She also used the Wiki as a means of communicating with the Scion team – in particular the scientists who came to the school for the gully investigation – to gain their feedback and guidance on the practical investigations the class was involved in.

The Wiki was the principal communication tool used for this project, and it was apparent that it served its purpose effectively in engaging both parents of students in the class, and the wider school community, in this project,

…having the Wiki space… it's a vehicle for sharing information and what we are doing… the feedback from parents was great… they were really excited about how enthused the kids were, they were all coming home from school talking about it. One Mum who has three children at school said they were all talking about the same thing… asking each other questions, getting on the Wiki… with the Wiki they (parents) can see what we're learning… they can get on at home…

(Helen, interview transcript, 2009, p. 3)

In addition, the use of the Wiki was fundamental to encouraging students who were usually reluctant writers to engage with the study, Helen commenting that the authenticity of the project and the fact that they were communicating with a 'real' audience via the Wiki was hugely motivating. According to her, both the volume and quality of students' written language improved significantly during the study, because using the Wiki,

> *…gives them more of a sense of purpose, they've got a real audience… it's not just us (the class) seeing it. Often you do work, and you know it's great learning and stuff, but it stays in the classroom, no one else gets to see it. For some kids, like one of my girls, not the best writer… but you should see her Wiki… she was downloading the photos and writing about them. It was huge motivation. It helped her literacy skills without a doubt. They don't realise they're reading or writing when they're on the computer.*
>
> *(Helen, interview transcript, 2009, p. 8)*

The development of the variety of skills needed the make best use of the Wiki was a collaborative process, with Helen often introducing skills as she acquired them, before demonstrating them and allowing the children to teach each other. She particularly commented on one boy who had social issues but was very good with the computer.

He valued the opportunity to teach skills to others, and in the process, "gain a bit of status" (Helen, interview transcript, 2009, p. 8).

Thirdly for Helen, the opportunity to have access to technology in sufficient quantities for it to be useful on a 'whole class' basis through the relationship with Scion, was highly significant professionally. She viewed the opportunity to learn about and use an array of new technologies such as the night vision camera and the digital microscopes as unique, and developed significant technical and problem solving skills as a result. The fact the any help from Scion was over 100km away, meant that if she encountered an issue she generally had to solve it herself, and this also applied to the uploading of data from the night vision camera to YouTube for installing on the Wiki,

> *It's a huge learning curve for me… with the technical things like the night camera… we had to take it down over the weekend… I had to reset it. It forced me to learn, I had to learn all sorts of things, like the Wiki and the video footage from the camera. I had to learn how to convert it into something we can see... it's really great when the scientists (from Scion) give us feedback on our Wiki, which they have done a few times…*
>
> *(Helen, interview transcript, 2009, p. 7)*

In many ways the fact that Scion personnel were not available 'on call' to assist with issues, worked in favour of developing a level of 'robustness' around this project where Helen and her students assumed responsibility for developing solutions to problems, or sourcing answers to science questions and inquiries. While Scion personnel were always there 'in the background' to support where needed or to respond to specific or difficult questions, they were viewed as only *one source* of information, amongst others. This was both significant and important, as sustainability of interactions such as this relies upon establishing a relationship which is not 'parasitic' in nature, but rather where support is provided by CRIs initially where needed, but with the longer term goal being to sustain such programmes largely from within the school.

In summarising this section, the provision of supporting technology by Scion as part of this interaction was absolutely critical to its success. During the course of the unit it acted as an essential tool to support independent student-led inquiries, enabled the collection and use of data which would have otherwise been inaccessible, and served as a highly effective medium for communicating project outcomes and gaining feedback and engagement from parents and community. The fact that it was available in sufficient volumes allowing for whole class access meant that management difficulties were lessened, and seamless integration into the day-to-day classroom programme was possible.

3.5. Knowledge development, the nature of science, and the importance of context

Consistent with the overall aims of the Science-for-Life project, one of the primary goals for this interaction was an enhancement in the level of science knowledge held by both the teacher, and the students. This not only related to the specific focus of the study (ie: the gully investigation), but also to understanding the nature of science, what the *purpose* of science is, and how it impacts upon our daily lives. To gauge a little of the initial views held by the students relating to such things, Helen administered a short survey before the unit began. What was particularly interesting about the results of this survey (Appendix 2) was that although the students had been actively engaged in a number of science topics over the previous two to three years, very few actually identified these as being 'science' in nature. That is, when asked about studies that they considered to be science, most students were unable to respond accurately. As Helen commented,

> *…as far as they were concerned, they had never done any science, and didn't know what it was – even though in term 2 we'd done a big focus on forests and plants… what a plant was, how it was different to an animal and so on… they didn't get that that was science…*
>
> *(Helen, interview transcript, 2009, p. 1)*

Additionally, as can be seen from the results of the survey, student views of science were extremely narrow and stereotypical in nature – being either related to the living world or planet earth, or concerned with "blowing things up… you know the mad scientists on TV" (Helen, interview transcript, 2009, p. 2).

In an effort to broaden these concepts and dispel some of the stereotypical views students held relating to the nature of science, an audioconference was held early in the project with an entomologist (aka Kerry) from Scion. The conference was based on an agenda of questions submitted by the class (Appendix 3), and focused on helping the students to develop a better idea of the work of scientists and how scientific investigations were carried out. During the conference Kerry provided a profile of her training, experience, and present projects, as well as responding to questions relating to the general nature of science,

> *…science is the gathering of knowledge… it is actually a way of thinking… I guess most of all science is about learning lots of little things and adding it to other people's knowledge. Every now and then someone comes up with a brilliant idea… but not me for the moment… mostly it is about adding it to what other people have learnt…*
>
> *(Kerry, audioconference transcript, 2009, p. 3)*

Kerry also actively sought to make links between the nature of science and what the students were investigating in their gully project, commenting that the sort of activities they were involved in were not dissimilar to her own work. She emphasised the importance of hypothesising and question asking, designing experiments and analysing and reporting on outcomes, and holding an inquiring attitude, to the successful undertaking of science, and she constantly drew parallels to the work of the students,

> *…the whole process of planning an experiment, thinking up questions and working out how you are going to answer them with an experiment… finding the answer. You have to want to know what's going on around you… how things work… and be interested in finding out more. You need to think clearly and plot solutions… just like you guys are doing in your gully…*
>
> *(Kerry, audioconference transcript, 2009, p. 3-5)*

At the time of writing a follow-up survey was due to be completed, which will compare the initial perceptions held by the students with those existing at the completion of the study. These will be reported on in a subsequent paper.

The audioconference with Kerry also assisted Helen to refine her investigations with the children, and to learn more about how to set up experiments and draw conclusions. This learning was continued through subsequent interactions with Andy and two Scion scientists, who visited the school on several occasions assisting with the identification of plants, helping students understand how the gully was formed, and advising on the design of predator investigations (Helen, interview transcript, 2009, p. 2). These investigations were subsequently written up by the children as experiments, using a format introduced by Kerry and Andy, and posted on the class Wikispace.

One of the most significant benefits Helen identified for her from the Scion interaction was an increase in both her content knowledge and her understanding of 'correct' scientific procedure. While she commented that the Internet was a valuable resource to help 'learn the science' behind the study, she also considered she did not have enough understanding to be in a position to work out what was and what wasn't valid and accurate information. She stated that the relationship with the Scion scientists provided her with a level of assurance in this respect, as she was able to use the resources provided by them to cross check other references before introducing the concepts to the class. She considered the 'contacts' she had made as a result of this project were one of the most significant outcomes, and that they would prove to be a valuable asset for any future studies she may undertake,

> *…my own knowledge base isn't huge in any of this… you can go to the Internet, but there's so much information… it's hard to know what to take and what to leave. I just have to email (Scion) and ask if they have any information about this… it's having the contacts… I just emailed today and asked him (Dave – a scientist) if he had any information on deforestation… and he sent me though a whole slideshow…*
>
> *(Helen, interview transcript, 2009, p. 4)*

Another factor seen as a considerable strength of this interaction was the use of a local, authentic context for the study. Helen commented that the presence of the gully immediately adjacent to the school, in conjunction with the planned class visit to the Maungatautari restoration project[3], afforded a unique opportunity to complete a comparative study investigating similarities and differences between the two environments, while at the same time learning about procedures such as predator control and other restoration processes. Much of the knowledge acquired through the trip to Maungatautari Helen saw as being applicable to the school gully, in that the students gained "an appreciation of the native birds, and the relationship between the whole gully environment… because it's local… it's all part of our community… it's all linked" (Helen, interview transcript, 2009, p. 6). She hoped that through active participation in the interaction, that the children would gain a greater appreciation for the gully, the threats to its flora and wildlife, and why it's so important to protect New Zealand's native bush generally.

4. Summary, conclusion and recommendations

In summary, it would be fair to state that this pilot was a successful interaction, while at the same time providing tentative insights into how future interactions may be planned and developed. As introduced above, outcomes not only related to information about the establishment and undertaking of such interactions, but

[3] For further details of this restoration project, please see http://www.maungatrust.org/subpages/mountainrestoration/restoration.asp

also to the quality and depth of science the students were engaged in as a result of the interaction. Many of these latter outcomes have been adequately described previously, but it is still worthy of mention here, as it is the primary goal of Science-for-Life.

Whilst acknowledging issues in drawing any significant generalisations from such a limited case, there are several features of this interaction that should be considered in future planning, and for other organisations considering similar initiatives. These are summarised below:

- **Negotiate interactions**. Holding joint planning meetings during which shared understandings of expectations, levels of resource provision, specifics of, and timetables for contact (etc) are developed, is essential. All stakeholders must be able to formally plan ahead of time, and have confidence in, what will take place and when. It is especially important at the school end that agreements and understandings made are adhered to as much as possible. While some flexibility is important to respond to emerging and changing learning opportunities, changing plans at the last minute can lead to disappointment for students and teachers;

- **Interactions must focus on building, rather than *substituting* for teacher capability**. Danger exists in programmes such as this that instead of interaction, there evolves something of a dependency relationship between the teacher and the supporting organisation, which is unsustainable longer term. Interactions must be developed carefully, and focus both on the teacher and the students, in aiming to build independent capacity;

- **Focus strongly on helping students develop understanding of the *Nature of Science* as well as content knowledge in science disciplines**. Whilst acknowledging the limitations of this study, students' constructs of science were poor and stereotyped, and every opportunity to modify this should be capitalised upon;

- **Provide technology and science-related resources to support Inquiry learning.** Access to technology such as digital microscopes, laptops (Netbooks), and digital cameras in volumes sufficient for group work proved crucial to the success of this interaction. It not only facilitated access to rich and varied data, but through the use of Web2 tools such as Wikis and Blogs, it also engaged a wider audience and added authenticity and validity to the work of the students. It is therefore suggested that ICT 'kits' are developed by CRIs (or equivalent organisations) to loan (hire/rent) to schools participating in interactions;

- **Link with local contexts.** One of the significant strengths of this interaction lay in the fact that it was located in a local and accessible context (ie: the school gully). Where possible, it is recommended interactions identify contexts for studies which do not impose significant logistical or educational impediments (eg: access, cost, lack relevance or personal identification by students, are too abstract or removed, lack opportunity for 'hands on' practical student engagement etc);

- **Reach an agreed understanding of what 'collaboration' means**. While the Science-for-Life project focuses on CRIs and their support of school science programmes, it needs to be acknowledged that CRI (and equivalent) personnel generally do not have a strong knowledge of school curriculum, assessment, or planning processes (etc). Therefore, it is important that participating teachers collaborate by communicating and sharing such information, to help build this capacity at the CRI end;

- **Build project 'status' within CRIs**. The success of this interaction was due largely to the goodwill displayed by science personnel within Scion. Apart from the Scion project manager whose position is partially funded, all other inputs from the Scion staff were voluntary and in addition to normal workload requirements. Scenarios such as that described in this study may be unsustainable long term, in environments where there is a strong commercial imperative and competition for time and funding. If interactions of this nature are to be viable longer term, a mechanism needs to be developed whereby CRI staff are able to participate on a cost neutral basis (personal/institutional). To assist with this, the use of ICT to link scientists with the classroom is highly recommended, and interactions negotiated which as seamlessly as possible integrate with the daily activities of CRI personnel;

- **Carefully select participating CRI personnel**. Any personnel involved in such interactions should be carefully selected, not only on the basis of their capacity to contribute knowledge to the study, but also on their ability to relate this appropriately to students. As a rule scientists do not have teaching backgrounds, and may need guidance and input from the teacher to translate their knowledge into a form accessible by students.

It is expected that future case studies demonstrating different types of interactions as part of Science-for-Life, will broaden the base of data from which a set of overall principles and illustrative models can be developed to inform more general CRI-school interactions. While this is only the first study in the series, it has provided some useful indications of the efficacy of the concept, how such interactions might be planned and implemented, and the overall benefits for improving the quality of science teaching in schools.

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Appendix 1: Interview schedule for participating teacher

1. Could you please briefly describe the science unit which has been the focus of your work with Scion – objectives, content etc (elaborate);

2. Did you have any specific goals or objectives for the interaction, upon entering into it? Did these change in any way as the interaction developed?

3. Could you please briefly outline the activities to date within your unit, which have involved the staff of Scion?

4. How would you summarise the outcomes (benefits/other) for you (in terms of your professional activities) from this interaction? (elaborate)

5. How would you summarise the outcomes for your students from this interaction? (elaborate)

6. Were there any significant issues related to this interaction, in terms of its setup and operation, which detracted from its value for you or your students? (elaborate – possible improvements?)

7. Would you consider favorably the opportunity to be involved in another interaction sometime in the future? (Why? elaborate)

Appendix 2: The student perception of science survey

1. What is a scientist?

Responses:

Invents things (4), studies germs (2), chemistry (2), experiments (6), solves problems (3), discovers things (4), a nerd, good with chemicals, makes stuff, do cool things, makes discoveries, invents medicines, blows up things, good at maths, smart, finds solutions.

2. What sort of people are scientists?

Responses:

Smart people (14), lab doctors, archeologists, creative thinkers (13), intelligent (2), good at maths, don't talk much, good drawers, nerds, helpful, clean, imaginative, inventive (2), focussed, find things out, good people, hard workers, rich, keep trying, study stuff.

3. What are some of the things that scientists do?

Responses:

Do stuff for our world, make chemicals (5), try to improve the world, study (2) and invent, experiments (3), find out things, investigate (2), make cures (6), study germs, medical issues, explore new ideas (2), play with things, make things safe.

4. What sort of jobs do they have?

Responses:

Exciting jobs, interesting, hard, make sure things are safe, in a laboratory, make things (2), work with chemicals (3), plants, animals, space, (2) fossils, disease, boring, pays well, experimenting, investigates crime, dinosaurs.

5. On a scale of 1-10 how much do you think you understand about science?

Response:

2 5 6 4 2 2

1 2 3 4 5 6 7 8 9 10

I understand very little I understand most things

6. How much do you enjoy learning science?

Response:

1 3 1 5 2 1 3 8

1 2 3 4 5 6 7 8 9 10

I don’t enjoy it. I love it.

7. What do you enjoy learning about in science?

Responses:

Experiments (7), working with chemicals (2), how things work, exploding things (2), fun (2), bugs, never done it, stuff that goes high in the air, something different, computer, why things happen, boom, animal biology, lifecycles.

8. What have you studied in science over the last few years?

Things we have in our world, environment, caves (2), plants (4), snakes, sea studies, bugs, gravity, dinosaurs,

9. How important is science to the world?

Response:

2 1 1 2 9 10

1 2 3 4 5 6 7 8 9 10

Not important Very important

10. Can you name some things science has done for good in our world?

Responses:

Cars (3), finding cures, find where paintings come from, going to the moon (2), light bulbs, power, lights, machines, mechanical arms, bombs, helped others, medicine (2), solar energy, how old things are, computers, how to stay healthy, solar system, cured the black plague, cured cancer, music, microscopes.

11. Can you name some things science has done that has harmed our world?

Responses:

Radioactive spills (2), atomic bomb (3), pollution (2), drugs that harm people, global warming (2), make toxic stuff (6), poisons (2), nuclear bombs, using animals as tests, kill plants.

12. Can you name some famous scientists?

Responses:

Albert Einstein (10), Leonardo Davinci, (3), Thomas Edison (4).

13. Can you name any T.V. programmes that use science?

Responses:

Dr Who (6), Ben Ten (2), Discovery (4), Rove, Myth Busters (6), Dr Dolittle (3), Let's Get Inventing (2), National Geographic (2), Phineas and Ferb, What Now?

14. How do they use Science?

Responses:

Do experiments (2), invent new stuff (4), to find results, creating new things to help people.

Appendix 3: Student-developed interview questions for Scion scientist (Kerry)

1. What job do you have as a scientist?

2. What are the different types of jobs at Scion?

3. Do you know any early scientists?

4. Where do scientists originate from?

5. What did you need to do to become a scientist?

6. Have you made any famous discoveries and what were they?

7. What part of your job do you enjoy?

8. What inspired you to become a scientist?

9. How long have you been a scientist?

10. What projects have you been working on lately?

11. How do you help the environment?

12. What made you interested in trees?

13. Have you regretted any of your discoveries for work?

14. Who came up with the name Scion?

15. What sort of a person do you need to be in order to be a scientist?

16. What skills do you need?

17. Have you found germs that can kill plants, inside trees?

18. Why are animals used in experiments?