Ridgewell, Jay and Exley, Beryl E. (2010) ***The potentials of student initiated netspeak in a middle primary science-inspired mutliliteracies project.*** Research in Science Education.

Final Author Copy

Published as: Ridgewell, J. & Exley, B. (in press, accepted 2010) The potential of student initiated netspeak in a middle primary science-inspired multiliteracies project. *Research in Science Education*.

The Potentials of Student Initiated Netspeak in a Middle Primary Science-inspired Mutliliteracies Project

Jay Ridgewell & Beryl Exley

Abstract

There is no denying that the information technology revolution of the late twentieth century has arrived. Whilst not equitably accessible for many, others hold high expectations for the contributions online activity will make to student learning outcomes. Concurrently, and not necessarily consequentially, the number of science and technology secondary school and university graduates throughout the world has declined substantially, as has their motivation and engagement with school science (OECD, 2006). The aim of this research paper is to explore one aspect of online activity, that of forum-based netspeak (Crystal, 2006), in relation to the possibilities and challenges it provides for forms of scientific learning. This paper reports findings from a study investigating student initiated netspeak in a science inspired multiliteracies (New London Group, 2000) project in one middle primary (aged 7-10 years) multi-age Australian classroom. Drawing on the theoretical description of the Five phases of enquiry proposed by Bybee (1997), an analytic framework is proffered that allows identification of student engagement, exploration, explanation, elaboration and evaluation of scientific enquiry. The findings provide insight into online forums for advancing learning in and motivation for science in the middle primary years.

Keywords: 5Es model; elementary science; ICTs; netspeak; phases of scientific learning; Primary Connections; primary science;

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School-science: Problems of the moment

Not only has the number of science and technology secondary school and university graduates throughout the world declined substantially, the most recent Organization for Economic Co-operation and Development (OECD, 2006) data from the Programme for International Student Assessment (PISA) point to a lessening of student motivation and involvement in school sciences for a significant number of 15 year olds in the 50 participant countries. The data also found that, on average, 5.2% of students were unable to complete the lowest level of tasks, Level 1. PISA, in taking up a citizen orientation to school science, assesses these students as "at a serious disadvantage for full participation in society and the economy" (OECD). On the same measure, just fewer than 20% of students, on average, could not perform Level 2 tasks. Whilst the PISA manifesto claims this is not an indicator of "a threshold for scientific illiteracy", the forecast is that these students would be unable to "participate effectively and productively in life situations related to science and technology" (OECD).

The concurrent world-wide demand for science professionals to maintain growth and development in science and technology and the realisation that citizens need to be scientifically literate have burgeoned. Kolstoe (2000) argues that citizens need an understanding of science that transcends traditional subject content so as to be engaged with democracy and decision-making on socio-scientific issues. Whilst acknowledging the multiple points of view on the definitions of scientific literacy, Murcia's (2009) reduction of the key points is helpful: [i] understanding of the more important scientific ideas which are relevant to everyday situations in the present and the future, [ii] understanding of the 'Nature of Science' (NOS), which includes the values and assumptions inherent in the development of scientific knowledge and its epistemologies, and [iii] an application of science in everyday life, and evaluation of its effect on the social and natural environments (p. 218).

The international call for an improvement in the teaching of science to promote higher levels of scientific literacy, has heralded major national projects in the UK, the US and Australia. The UK's project, *Twenty First Century Science*, involves a national pilot of 12 000 students (Millar, 2006, p. 1500). The *Science for all Americans* programme states that "schools do not need to teach more and more content", rather "focus on what is essential to scientific literacy and to teach it more effectively" (Millar, p. 1500).The Commonwealth inquiry in Australia in 1989 was titled the *Discipline Review of Teacher Education in Mathematics and Science.* A key revelation of this report, and others since (Goodrum, et al., 2001; Peers, 2007), is that science teaching in Australian primary schools is in "a state of crisis". The ensuing reaction from the Australian Government Department of Education, Science and Training (DEST) has been to invest in the *Primary Connections Project*, a series of professional development programmes for science coordinators in selected primary schools as well as the production of a series of instructional handbooks made available to all teachers throughout the country for a small processing fee. The underlying theoretical and pedagogical base of this programme is Bybee's (1997) five phases of enquiry.

Lee and Erdogan (2007) offer causal relations to explain the falling engagement with school science, citing that current science teaching practices reduce rather than encourage students' natural curiosity and leave students with a negative attitude towards science. Fensham (2007), in his address to the World Conference on Science and Technology Education, concedes that comparative employment prospects, and the promulgation of negative images of science in the media, may also be responsible. Throughout his address, Fensham also postulated that primary[1] school teachers' lack of pedagogical strategies and content knowledge to teach science as intended may be contributing to student malaise. As a case in point, reflective commentary from science education researchers from the United States suggested that 'most elementary teachers have not heard the term *nature of* science, and when they see it in their state frameworks misinterpret the term as meaning something to do with nature, not as the essence of science itself' (Akerson, Buzzelli & Donnelly, 2008, p. 748). Whilst the finger of blame does not solely rest on the teaching of science at the primary levels, examination of new forms of learning delivery in these formative years of schooling warrants closer scrutiny for two reasons: [i] these years of schooling constitute the period of time where initial attitudes to the more formal years of school science are grounded, and [ii] there is a dearth of literature on the capabilities of Information Communication Technologies (hereafter ICTs) for motivating and advancing middle primary students' engagement with scientific enquiry.

In light of the preceding discussion, it is prudent to cast a research lens onto primary school science and the demonstrations of scientific enquiry made possible by a department-approved online forum. The remainder of this paper is presented in four sections. The next section theorises the communicative base of what Crystal (2006) terms as "the new species of communication" -- netspeak. The second section introduces the empirical case study that will be explored, a science inspired multiliteracies (New London Group, 2000) project with the inquiry question ‘Micro-organisms: Good or Bad?’. This project was undertaken in conjunction with an online forum in a middle primary multi-age class (aged 7--10 years) in a small inner-city Australian school. The third section expands on the five phases of enquiry as advanced by Bybee (1997) to develop an analytic framework capable of identifying the forms of scientific enquiry evident in the case study online forum. The final discussion centres on the possibilities and challenges of online forums for engaging and advancing scientific enquiry in the middle primary years.

Netspeak: The New Species of Communication

An expectation exists that ICTs will improve learning; however, a review of currently available literature points to the existence of a gap between the pervasiveness of this discourse and the actual progress of ICTs in adding value to teaching and learning efforts. Frequent criticism of ICT use in schools concerns outcomes quality. Back in 1999 Stoll argued that much of what is done with computers in schools is not very challenging and maybe less valuable than what it displaces. Tapscott’s (2009) more recent documentation draws on a range of empirical examples from around the globe to argue that these negative outcomes are due to what he calls ‘the hard wall of entrenched thinking about education’ (p. 144). He concludes that it is not just teachers’ own limits of computer knowledge holding the curriculum and pedagogies to ransom; refusal to also fundamentally change the education system for new ways of 21st century learning compromise the success of any technical revolution (p. 145).

Such statements foreground the urgent need to better understand how students connect with various forms of ICT, for example, online forums. Online forums are described by Crystal

(2006, p. 12) as asynchronous (postponed time) communication where interaction is stored in some format and made available to users upon demand. Online forums are simply not the same as other kinds of sites. They display fluidity, simultaneity (being available on an indefinite number of machines) and non-degradability in copying, transcend traditional limitations on textual dissemination, and they have permeable boundaries where one text may become integrated with another (e.g. hyperlinks) (Crystal, 2006).

In addition to the above concerns with ICTs generally, the literature reports a plethora of obstacles for users of online forums, including [i] the time taken to acquire and set up the technology, and [ii] the need to adapt to the literacy demands of the new context, both for consuming and producing text (Ng & Gunstone, 2002). The demands are augmented by the multiple pathways of access as well as the continually evolving forms of non-linear navigation that need to be mastered (Thurstun, 2000). By way of example, engagement with online forums requires an ability to understand icons and hieroglyphics and to navigate between graphic displays, layouts and hypertext that take users away from the main screen (Gibbs, 2000). The various links constitute possible orders of assembly and reading/viewing, each producing a different trajectory. Unlike books, online forums have neither a beginning nor ending. Viewers can browse through the domain freely and choose when and where to leave the experience. This requires viewers to take a more active role, where engagement is potentially more learner-centred.

Other research underscores the substantive and productive impact of ICT advances on the (re)construction of forms of school content knowledge, including science content. Writing generally about online forums, Frank (2006, p. 376) supports the claim that they are

> “ … particularly suited to the study of subjects based on the exchange of ideas, topics into which participants want to delve deeply, concepts that are in dispute, topics that are important to look at from a number of perspectives, and issues around which disagreements and arguments are likely to arise”.

A further potential contribution of online forums to scientific enquiry can be understood by drawing on the work of Vygotsky (1962), who articulates a socio-cultural theory of intellectual development in which the social experience of oral language (talk) is a major shaper of cognition. Allied to this point is the notion that online communication is a resource for shared meaning making. Importing notions of ‘conversation’ to a digital asynchronous repository, however, is not straight forward. Whilst commonalities are acknowledged, netspeak has its own peculiar syntax and semantics (grammar) that means it is neither a spoken nor written conversation. Put another way, netspeak constructs meaning in different ways to that of typical ‘choreographic’ spoken and ‘crystalline’ written conversations (see Halliday and Matthiessen, 2004, p. 656). The plethora of work from researchers operating within the Sydney School of Linguistics attests to this. However, the linguistic organisation of the grammar of netspeak is not the concern of this paper. What is of concern is the function of online forums as the engaging medium of new millennium forms of ‘conversation’, in particular its potential for participants to relate to and express their opinions about the topic at hand, to read the material submitted by other participants and to submit their own response should they wish to contribute. Like real-time face-to-face conversations, online conversations harness the potential to stimulate the development of reasoning, problem solving, and decision making (Todd, 2000). Unlike real-time face-to-face conversations, individual users can control their engagement with the online forum, thereby controlling the pacing and sequencing of learning, which, according to Ng and Gunstone (2002) has significant motivational benefits. To explicate, student control is realised through electing to (or not): backtrack (i.e. re-read past posts); multi-task (e.g. carrying out research on the internet whilst also making a contribution to the forum); use written or visual text forms; select or ignore the traditional linear reading path; and structure the domain of knowledge. Thus, the potential of online forums is heightened, as “individual learning is enriched while there is interactive social support in the building of knowledge and development of thought processes” (Frank, p. 376).

Subscribing to the line of thought that ‘talk’ is ‘the most ephemeral and commonly overlooked of classroom elements’ (Hacking, Smith & Murcia, 2010, p. 17), we propose that online forums are worthy of further exploration. Yet, little is known about the possibilities of online forums for advancing engagement and scientific enquiry in the middle primary years. Our research is thus focused on evaluating a virtual space where the case study middle primary students entered into unscripted conversations. Our analyses are focused on identifying the forms of scientific enquiry evident within that space over the life of the project. The next section introduces the case study context and its 19 middle primary student participants.

The Case Study Context

The context of this case study is a multi-age class in a small school in an inner-city suburb of Brisbane, the capital city of Queensland, Australia. The school, named Bushland State School (pseudonym), is set in a middle to low socio-economic demographic, and as the name would imply, is surrounded by bushland. As evidenced through departmental student and parent surveys, Bushland State School has achieved significant parent and local community support in the last four years since the school undertook substantive curricular, pedagogical and assessment reform. The teachers worked with the community to re-establish their commitment to teacher-student negotiated long-term project tasks to redress increasing student disengagement, falling literacy standards and teacher boredom with existing programmes. These projects, known as multiliteracies projects, adopt a transformative orientation that: [i] foregrounds inquiry and situates content and its modes of representation in the life worlds of students, [ii] provides overt instruction that names and theorises content and modes of representation and extends these into new knowledges, [iii] integrates critical framing at every stage, and [iv] culminates in the application of content and modes of representation for real audiences (Kalantzis & Cope, 2005; New London Group, 2000).

Mrs Sarah Bellum (pseudonym), a teacher with over two decades primary teaching experience, is the case study teacher. In her own words, she is ‘strong with the basics, not particularly switched onto computers, but committed to and enthusiastic about the multiliteracies project approach’ (fieldnotes). Like the primary school teachers identified in Evans and Rennie’s (2010) longitudinal interview based study, Mrs Bellum had some understanding about scientific literacy, but was not overly confident with her substantive knowledge base (fieldnotes).

The Science-inspired Multiliteracies Project

The impetus for the eight week multiliteracies project was one of the Australian Academy of Science *Primary Connections* (2005) publications, *Marvellous Micro-organisms*. The publication provided background reading and a range of hands-on activities and discoveries that extended her content knowledge and the students’ experiences. In the spirit of multiliteracies projects (Kalantzis & Cope, 2005; New London Group, 2000), Mrs Bellum did not limit learnings to the guide; an inquiry was negotiated between Mrs Bellum and her 19 middle primary students early in the project: ‘Micro-organisms: Good or Bad?’. Students’ motivation for inquiry was borne out of a situated role play drama where two ‘scientists’ (acting principal and author 2 in role) were working in opposition: one researching micro-organisms to take control of the world; the other researching micro-organisms so as to be more educated about the natural phenomena and the effects of human intervention. Working in small teams, students:

- undertook searches and hands-on activities so as to learn content information about micro-organisms;
- decided which scientists’ actions they could morally support, and;
- designed and presented a multimodal persuasive text using the newly acquired computer animation software, Kahootz 3.0 (Australian Children’s Television Foundation, 2007) at a community vote which would determine which scientist would be given the students’ research findings about the natural phenomena of micro-organisms and the potential of human interference, and which scientist would be banished from practising science.

Students also had access to three other significant adults during the project:

- an industry-based scientist (father of a student at the school) who visited the classroom on a few occasions to calibrate the newly purchased digital microscope and the ageing manual microscopes acquired from a nearby secondary school, show the students how to prepare slides to examine micro-organisms in food and creek water, and add half a dozen posts on the forum that answered students’ questions about micro-organisms.

- a parent of a student in the class with an interest in the computer animation software (Kahootz 3.0) who worked with groups of students on a weekly basis, as well as made a dozen posts to the forum site regarding the mechanics of Kahootz 3.0.
- a final year pre-service teacher from a local university who worked in collaboration with Mrs Bellum for a month, and made half a dozen posts to the forum site that directed students’ attention to useful websites about micro-organisms.

The transformative orientation evidenced here privileges content relevance, a citizenship/society/socio-scientific foci, and a pedagogy of inquiry over science as pre-determined and pre-sequenced content and skill (see Exley & Luke, 2010 for a detailed discussion). Mrs Bellum orchestrated a team of five additional adults and 19 middle years students working in small groups. Such an approach is fundamentally democratic in the sense that diverse viewpoints are brought together for deliberations. The situated role play drama was indeed central in creating the moral problem and need for scientific exploration of the natural processes of micro-organisms and the effects of human intervention. The solutions to the inquiry problem were not pre-determined; rather they emerged from unpredictable and indeterminate real-life and the online conversations.

<u>The Online Forum</u>

Alongside critically framed cycles of situated practice and overt instruction focused on science content (good and bad micro-organisms and the effects of human intervention) and multimedia (using a digital microscope, and the Kahootz 3.0 software), Mrs Bellum set up a department-approved asynchronous online forum so that students could post questions, findings and/or continue their real-time conversations virtually. The 19 student participants, aged between seven and 10 years, were all given a separate password to access the site on one of two networked computers in the classroom or from an external service provider (e.g. home). This online forum was not core to teaching and learning; students were invited to participate if and when they felt like it over the course of the project. The choice made by Mrs Bellum to not use this trial project for summative assessment ensured the space was casual and optional. Lankshear and Knobel (2003, p. 17) caution that using online forums in a 'school-like' way runs the risk of eradicating 'idea development' and 'strongly held points of view'; Mrs Bellum's students could begin with their felt sense of purpose and take it from there.

Aside from creating awareness (a single lesson conducted by Mrs Bellum and the parent with an interest in ICTs) and providing accessibility, neither teacher intervention nor teacher direction was given. Like the educators described in Tapscott's (2009) documentary, Mrs Bellum adopted a 'revolutionary' approach that acknowledged the students as authorities on how to interact with a virtual networking site. Throughout the course of the project, the students, two 'scientists' in role, the visiting industry-based scientist, the parent with an interest in ICTs and the pre-service teacher produced 49 x A4 pages of transcript through 237 online posts. One hundred and forty-seven posts were either: [i] communication between the students and the other adults regarding visits and/or taking sides in the upcoming vote, or [ii] students asking and receiving information from their peers about the computer animation programme Kahootz 3.0. Of interest to this research paper are the 90 posts from the students relating to science content discussion. In the next section, we offer a language of description derived from the work of Bybee (1997) for analysing the forms of scientific enquiry in the case study data.

Bybee's (1997) Five Phases of Enquiry

The five phases of enquiry, also known as the 5Es model, as advanced by Rodger W Bybee (1997) in his landmark book, *Achieving Scientific Literacy: From purposes to practices*, encompasses the following non-hierarchical phases: engagement, exploration, explanation, elaboration and evaluation. In Bybee's words (p. 170) "doing hands-on activities in science is not enough. Those experiences also must be minds-on". Use and utility of the model has been documented by teachers from the Biological Sciences Curriculum Study (BSCS) where Bybee was an executive director. Since that time Boddy, Watson and Aubusson (2003) employed the 5Es inquiry framework to investigate the range of learning theories taken up in a project of work for an early primary class (aged 7-- 8 years). This group of researchers used phenomenography and Baird and Northfield's (1992) List of Good Learning Behaviours to analyse interviews and video-taped class sessions. Findings evidenced the promotion of higher order thinking of some students, including some who had not previously exhibited the skills, and by no means disadvantaged any of the students. Furthermore, the study of language rendered visible the incorporation of learning into the fabric of existing information and understanding (Boddy et al., p 36). The 5Es model has also become the cornerstone, albeit an adaptive version, of the Australian Academy of Science's nationwide *Primary Connections* initiative.

One of the problems with scholarship related to the 5Es has been clarification of definition. The 5Es are neither tangible, fixed, nor something that can be listed. Rather than delineating the content of each, Bybee (1997) overlays seminal educational theories of connecting to prior knowledge, unbalancing the cognitive equilibrium and engaging in reflective thinking to form the 5Es model. The Australian Academy of Science, however, aligns each with stages within a teaching and learning cycle. Each of the 5Es phases, as articulated by Bybee and re-defined by others (Australian Academy of Science, 2005; Boddy et al., 2003), is described.

Engagement

Bybee (1997) posits the core premise of the engagement phase is to connect future and past activities and cites student puzzlement and motivation to continue as markers of successful engagement. Quoting Swanage and Lane (1999), Boddy et al. (2003) state the purpose of the engagement phase is "to capture children's imagination". The Australian Academy of Science (2005, p. vii) extends understandings, describing this phase as the time to "engage students' interest, stimulate curiosity, raise questions for inquiry, and elicit [students'] existing beliefs about the topic".

Exploration

Bybee (1997, p. 180) emphasises that the exploration phase provides the "opportunity for students to interact, discuss, and even argue in a constructive environment" in such a way that "current concepts will be challenged and other ideas will be evident as they reconstruct their ideas". The Australian Academy of Science website (*About Primary Connections*, 2008) adds that authentic exploration involves hands-on activities where students can explore the concept or skill to be learned and be able to describe it in their own words. Thus the explore phase allows individuals in the class to participate together in an experience relating to the concept that they will later be able to discuss and explain.

Explanation

A marker of the explanation phase is the introduction of scientific terms and explanations by the teacher, so that the class has a common language to describe their experiences (Bybee, 1997). In taking up a student-centred model that extends into overt instruction, Boddy et al. (2003, p. 29) maintain that students should first voice their developing conceptualisations before the teacher offers their explanations. Thus it is through the explanation stage that students show evidence of (re)developing their own conceptual mis/understandings.

Elaboration

According to Bybee's (1997, p. 181) original definition, "[g]eneralisation of concepts, processes, and skills is the primary goal of the elaboration phase". "This phase is vital in developing more general views of phenomena, as children identify similarities in different contexts" (Boddy et al., 2003, quoting Swanage & Lane 1999, p 30). Exemplar practice within the elaboration phase, according to the Australian Academy of Science (2005), is typified by students planning and conducting their own open investigation to test and extend their understandings.

Evaluation

Seen more holistically by Bybee (1997), the evaluation phase is for students to further develop their understanding by evaluating what they now know and can do. For example, evaluation involves students determining the adequacy of an explanation of scientific phenomena and from there posing related questions for future investigations. The *Primary Connections* (Australian Academy of Science, 2005) units, however, interpret the evaluation phase as a stage of teaching and learning whereby students create a product to represent their conceptual understanding for teacher assessment.

Adopting the definitions proffered by Bybee (1997) and Boddy et al. (2003) because of their focus on enquiry rather than stages of teaching and learning, we developed an analytical framework capable of identifying the forms of scientific enquiry evident within students' online postings (see Table 1, below). Our work stands aside from Hackling, Smith and

Murcia's (2010) theorisation of Mortimer and Scott's (2003) communicative approach which developed a framework to describe and categorise classroom discourse. The point of difference is our analytical framework is specific to student generated online postings. After considering all 90 posts, the following spread of findings were summarised in Table 1, below. Student names are pseudonyms. Maintaining our interest in representing the students' work as authentically as possible, spelling, punctuation and/or grammatical errors were not repaired, except for where meaning may have been ambiguous. In these situations, we offer our reading in squared brackets. For the most part, what Crystal (2006) refers to as writing in its "naked, unedited form", did not distract from the content of the message. Non-conventional spelling and lightly punctuated messages, given the relatively short sentence lengths, posed few problems. Crystal confirms that these sorts of errors/omissions are commonplace in online communication irrespective of the education background of the text producer.

[INSERT TABLE ONE HERE]

The quantitative data from Table 1 reveal two significant findings, one that relates to type and frequency of postings, and the other that relates to origin of posting.

In relation to type and frequency of postings, the data indicate that students offered posts that covered four of the five phases of scientific enquiry: engagement, exploration, explanation and elaboration. Evaluation posts were not identified. In terms of frequency, engagement posts (54%) were the most common, being twice as frequent as explanation posts (27%), three times more frequent than exploration posts (17%), and 18 times more frequent than elaboration post (3%).

In relation to the place of posting, the data indicate that 15 out of 19 students (78%) uploaded posts that originated from outside of school. It is not known if the other four students (22%) who did not upload posts outside of school time had web access. This is an important point. If access to ongoing conversation is not equally enabled, particular students cannot become part of the choreography of this avenue of scientific learning. The data also show that 60% of the posts made by the 19 students were made outside of school hours, compared with the 40% of posts that were made during school time. The non-school posts were sometimes made as late as 9pm. Many were also made on weekends and before school, indicating that the site was being accessed at a range of times other than what is often thought of as the 'afternoon homework session'. Thus, the class was both divided and together in its online experience of learning. Not only did the online setting separate student and teacher and student and student in learning time and space, the online medium also showed that learning time does not align with teaching time.

The qualitative data from Table 1 reveal findings relating to student cooperation and extensions to and borrowings from the pool of community knowledge on the World Wide Web.

The online asynchronous forum evidences signs of co-operative learning via technology. These posts show that the students were, in their own way, acquiring the rules of online communication despite not being given detailed or continuing instruction. As shown in the examples, students greeted one another *(Post 2. hi Jessie here why does mould grow onthings?),* responded directly to peers *(Post 8. yes timothy one doe's it's caould [called] a puffball from Katie and Emma),* worked co-operatively to produce a shared response *(Post 8. yes timothy one doe's it's caould [called] a puffball from Katie and Emma)* and shared their findings and encouraged others to do the same *(Post 1. [NS] On this cool website the first thing youhave to do is find the thing you think has a bacteria on it. Try the quiz and try the activity. Does anyone else know about this website? Does anyone else have a website they can share? Click on this or cut and paste. http://www.bbc.co.uk/schools/scienceclips/ages/10_11/micro_organisms_fs.shtmlso).*

As Post 1 shows, students were also borrowing scientific knowledge from the community knowledge existing on the World Wide Web. The difficulties of such an undertaking, given that information appears 'hidden' and its quality varies, are noteworthy. Students had to make judgements about the information to validate and authenticate the quality of instructional materials. There are, however, limitations of boundaries of the pool of community knowledge. Here the online forum is not the global medium it is often purported to be. Whilst in principle much has been made of the web's ability to transcend the limitations of physical environments, cultural differences and time-zones, thereby allowing people from anywhere at all to contribute (Crystal, 2006, p. 63), in this case, the departmental approved online forum is more restricted and parochial.

Other data that relate more specifically to the types of scientific enquiry and its spread across the life of the project, are provided in Figure 1, below.

[INSERT FIGURE ONE HERE]

Two significant findings can be drawn from Figure 1, which relate to the number of posts over the life of the project, and to the forms of scientific enquiry evidenced.

In terms of the number of posts during the life of the project, Weeks 3 and 4 produced the most scientific content posts. This peak was possibly in response to the hands-on activities being undertaken in class. Posts during these weeks made direct reference to the various activities. This point alone adds to the potential of hands-on science work for generating conversations of science content. It seems the common experience gave students something useful to add, for example, *(Post 4. [S] i think it looks like a spider web with black bits).* Although at least 78% of the students had some outside of school access to the online forum, no posts were made during the school vacation period (Weeks 5 & 6). The students were slow to start scientific content posts at the beginning of the project, and other areas of interest (i.e. discussion about visits from the two ‘scientists’ in role and students’ preferences for voting) dominated postings from the mid-point of the project.

In terms of the form of scientific enquiry evidenced, engagement type posts equalled or outnumbered any other type of posting in Weeks 1-- 8 inclusive. Almost all participating students posted one engagement post, thereby signalling their interest in the topic of micro-organisms. Although not clear-cut, there was a progression over time where engagement and exploration phase posts gave way to explanation posts in Week 9. Although elaboration posts were evidenced infrequently in Weeks 4 and 7, more elaboration posts were evidenced in Week 9 than any other type of post in Weeks 1, 2, 4--11 inclusive. This suggests two possibilities. Firstly, that time is an important factor in creating multiple forms of scientific enquiry in an online forum. Earlier in the project, the students tended to merely ask questions of the forum audience *(e.g. Post 3. [S] HI everyone can anyone anser thease three questions? Can mould be just green or diffrent colurs ? .What are those tiny little black dots you can see with a microscope ? What do spaws do?).* Later on, they started to bring information and answers to the discussion *(e.g. Post 10. [S] moulds produce spores which grow on plants and* *get food from them and they can stay in dormant state for hours. When the spore finds some food it will wake up from the dormant stage and grow and reporoduce).* We are, however, cautious to conclude that access to online forums over time will eventuate in students participating in an extended range of scientific enquires. Also, the nature of online forums means it is not possible to determine with absolute certainty the authenticity of students' posts. Students could have 'copied and pasted' information from the web, or an older sibling or adult may jointly construct a post with the student, or possibly even post in the students' name.

The second point worthy of note relates to Bybee's (1997) original thesis that the five phases of scientific enquiry are non-linear in development. Students continued to make engagement posts up to Week 10, and exploration posts up to Week 11. Explanation posts appeared in Weeks 1, 3, 4, 7 and 9. Elaboration posts were evident in Weeks 4, 7 and 9. These data thus affirm Bybee's powerful insight - scientific learning is not purely developmental; the online forum is a fluid world of thought where students are able to explore its possibilities of scientific enquiry as they desired. One notable absence, however, is that evaluation posts were not evident. This is a stark reminder of the importance of teacher scaffolding in school science activities.

Upon sharing the data and our interpretations with Mrs Bellum, discussion turned to the participation of one female student whom she described as 'reserved' in class, but 'surprisingly active' in the online forum. It seemed that this student found a new opportunity to contribute to conversations about science. Over the course of the project, this student posted 15 science related entries, 7 from a non-school source and 8 from school. Out of the seven non-school entries, two were categorised as engagement, one as exploration and four as elaboration. The eight entries that originated during school time were categorised as four each of engagement and exploration. This suggests that students who might be internalising phases of scientific enquiry, but too reserved to enter into class-based discussion, may find online forums a supportive and less confronting medium. Nettleback's (2005, p. 70) interview-based research with students using online forums considers students' approval for the "more private screen" over the "less private classroom". Thus, this datum suggests that the incorporation of an online forum changed patterns of participation for this student.

Concluding Discussion

There is very little documented evidence to suggest that ICTs are being used to transform aggregated learning in middle primary science in any meaningful way. To date, ICT uptake has focused primarily on trying to overlay new technologies on traditional forms of teaching, without making substantive changes to the character of teaching. The research reported here suggests that online forums engaged those students who could access it in ongoing dialogue about scientific content in different ways to programmed learning (e.g. *Primary Connections)* and real-time face-to-face class discussions. The data also suggest that online forums have the potential to contribute to the experience of scientific enquiry in and through wider learning spaces, in particular non-school sites and (parts of) the World Wide Web community. The findings also suggest that ICTs are a mechanism for allowing at least one student the opportunity to regain control over the learning experience. This warrants careful consideration given Lee and Erdogan's (2007) call to harness students' natural scientific curiosity. The essential impact of this latter point is the potential for supporting the diverse needs of learners operating on asynchronous schedules whilst also creating connectivity amongst learners, experience sharing, and information flow. In some way, online forums can add something substantive to teachers' strategies for engaging students in scientific enquiry, a point borne out of Fensham's (2007) address. In this case, ICTs also provided an authentic audience for students' work, and showed the important role of the teacher to harness the students' skills and motivation for ICTs. In this case, the teacher did not need to be an expert ICT user. Using the ICT in an online forum allowed more time and space for reflection than was possible in a teacher-lead class based discussion. The results suggest that netspeak can support some of the constructivist ideologies of a mutlitlieracies project (Kalantzis & Cope, 2005; New London Group, 2000), but on its own, it cannot achieve all forms of scientific literacy, most notably evaluation.

Of course discussing science in an online forum is by no means the whole of an effective science apprenticeship. This point was emphasised by the fact that substantive discussion did not commence until hands-on activities were offered in the classroom. Nor do we propose that online forums are the only way to redeem the dwindling appeal of science as a subject of study, a concern already highlighted by the OECD report (2006). Students must also be involved with other indispensable science learning activities, especially experiments, real-time discussions, lectures, demonstrations, visual image and interactions. In terms of this project, it is also difficult to know the impact of the team of parent and community extras. Such variables warrant closer examination in future editions of this research.

[1] Whilst the levels of schooling vary from State to State in Australia, primary school typically covers the first six to eight years of compulsory education where students generally range in age from 5 years to 13 years.

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TABLE ONE: 5Es phases of scientific enquiry – theory and analysis of online posts from middle primary multiliteracies project

Phases of Enquiry 5Es (Bybee, 1997)	Analytical Framework for Online Forum	Empirical Evidence of Phase [NS] = post from non-school origin [S] = post made during school time	Number of posts (percent of total)	Origin of Posting
Engagement	Evidence of student puzzlement or where students ask questions of themselves and/or forum users in relation to science content.	*1. [NS] On this cool website the first thing you have to do is find the thing you think has a bacteria on it. Try the quiz and try the activity. Does anyone else know about this website? Does anyone else have a website they can share? Click on this or cut and paste. http://www.bbc.co.uk/schools/scienceclips/ages/10_11/micro_organisms_fs.shtml* *2. [S] hi Jessie here why does mould grow onthings?* *3. [S] HI everyone can anyone anser thease three questions? Can mould be just green or diffrent colurs ? .What are those tiny little black dots you can see with a microscope ? What do spaws [spores] do?*	46 posts = 54%	school = 15; non-school = 31
Exploration	Evidence of students interacting, discussing, arguing about science content.	*4. [S] i think it looks like a spider web with black bits* *5. [S] I'm glad mould helps people when there sick but i think it's pretty gross* *6. [NS] thats a good question if micro organisms are around us that good be true.*	16 post = 17%	school = 10; non-school = 6
Explanation	Evidence of students defining scientific terms or processes in their own words, or reciting definitions of others.	*7. [S] hi joshua here, did you know bacteria that break down dead plants and animals like this are described as decomposing bacteria.* *8. [S] yes timothy one doe's it's caould [called] a puffball from Katie and Emma* *9. [NS] hiEmma I found out from a dictionary that a fungus is a group of mushrooms and in my mum's medical dictionary it said that a fungus is a little micro-organisms.*	25 posts = 27%	school = 10; non-school = 15
Elaboration	Evidence of students generalising concepts and/or identifying similarities in different contexts	*10. [S] moulds produce spores which grow on plants and get food from them and they can stay in dormant state for hours. When the spore finds some food it will wake up from the dormant stage and grow and reporoduce.* *11. [NS] Hi Edmund, we have good bacteria in our gut to help us break up our food. They are in a special part though called the lower intestine. If they get into another part of our body, for example the stomach, they can cause a tummy upset such as vomiting or the runs. There they would be called bad bacteria. That is why its very important to wash our hands after going to the toilet. We don't want bacteria getting into places where they shouldn't be.*	3 posts = 3%	school = 1; non-school = 2
Evaluation	Evidence of evaluation of scientific explanations and/or questions that build on scientific understandings.		0 posts = 0%	school = 0; non-school = 0

FIGURE ONE: Bar graph representation of scientific phases evidenced in online forum across eleven weeks of the case study middle primary multiliteracies project