

Using videoconferencing in a school-scientist partnership: students' perceptions and scientists' challenges

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This research studied a series of videoconference teaching workshops and virtual labs, which formed a component of a school-scientist partnership involving a New Zealand science research institute and year 13 students at a Wellington high school. It explored students' perceptions of the effectiveness of the videoconferences as an interactive medium for developing content knowledge, identified factors influencing their level of interaction during the conferences, and exposed issues when using videoconferences for highly specialised activities. The research followed an interpretive methodology using a case study approach, and employed mixed method qualitative/quantitative data gathering procedures. Results suggest that while videoconferencing was effective it was also expensive and time-consuming, and that scientists' efforts to engage students more interactively through movement towards more constructive practice, were largely ineffective. This article provides direction for teachers considering exploring the potential of interactive videoconferencing with students.

Keywords: science; partnership; school; interaction; engagement; pedagogy; videoconference; technology; ICT

Introduction

This article details a study in the use of videoconferencing in a school-scientist partnership between senior secondary school students and scientists from a government-owned science research institute in New Zealand. The partnership was part of a government programme designed to assist teachers and their students by exposing them to current science research and practice, based within local, authentic, and applied contexts (Scion Research 2008). The study draws on Engeström's (1987) Activity Theory principles of tool mediation and contradiction, to explore students' perceptions of the effectiveness of, and influences on videoconferencing, as a means of bringing them together with scientists in a series of teaching workshops and virtual labs, supporting their Biotechnology studies. It investigates factors that affected interactivity during the videoconferences, influencing scientists' efforts to evolve their practice towards more constructive and interactive videoconference use. The study focuses on a group of senior students (year 13 or 17–18 year olds) studying for their National Certificate of Educational Achievement (NCEA¹ Level 3) within the Biotechnology Achievement Standard 3.6 – “Describe applications of biotechnological techniques”.

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Research problem and questions

Interaction between scientists and students is not new, having commenced in the United States in the mid 1980s as a means of improving school science achievement. Most of these interactions involved direct face-to-face contact between scientists and students. However, recently issues with sustaining such interactions have been identified, given problems of distance, cost-effectiveness concerns, and greater demands on scientists' time (Falloon and Trewern 2012). This research institute shared these concerns, which were the motivating factors behind the decision to explore the effectiveness of using videoconferencing for the workshops and virtual labs, to engage the students who were located over 500 km away. The questions guiding data collection for the study were:

- (1) What were students' perceptions of the effectiveness of the videoconferences as a means of delivering content and illustrating science practice?
- (2) What factors influenced interaction between the students and scientists, and how?

General information on the design, planning and format of the videoconference workshops and virtual labs was also gathered, to help guide future practices.

Videoconferencing in education

Videoconferencing is not new, having been used in business contexts for a number of years, but "best practice" models for its use in education are still developing (Anderson 2008; Gage 2003; Gillies 2008). While some work has been carried out in tertiary settings investigating videoconferencing to support distance education students (Gillies 2008; Smyth 2005), few studies have explored its use in K-12 primary and secondary school contexts. Authors largely attribute the historical lack of penetration of videoconferencing in schools to cost and technology issues, with the price of equipment, prohibitive fixed line rental charges, and difficult setup and poor reliability of systems acting as major disincentives (Knipe and Lee 2002; Smyth 2005). Others point to pedagogical issues, as they perceive videoconferencing to be reinforcing teacher-dominated pedagogical discourses. Laurillard (2002) illustrates this by commenting:

Video conferencing invites the delivery of lectures. It is essentially a presentation medium as well as being a minimally discursive one . . . (it) as a medium, offers less than a lecture in terms of pedagogy, and wins mainly on the logistical value of bringing people together across a distance (pp. 157–158).

However, more recent work by Smyth (2005), Martin (2005) and Anderson (2008) argues that while the technology may lend itself to such use, it does not necessarily need to be the case. They comment that with technology improvements such as the advent of affordable Internet Protocol (IP)-based systems and high-speed data fibre networks, greater levels of student engagement and interaction through videoconferencing is now possible, and pedagogically, a move towards more student-centred teaching. Illustrating this, Martin (2005) details a number of case studies, one of which saw videoconferencing blended with conventional classroom experiences in bringing to life an ecology study of the Hudson River estuary. The videoconference was used to deliver "virtual field trips" to students, where a remote teacher took

them for an onscreen tour of the Hudson River. This was followed by a collaborative activity, where they remotely engaged with other students building a model of the estuary, before presenting their outcomes via videoconferencing.

Anderson's (2008) analysis of schools' use of videoconferencing over the Alberta SuperNet, also found that most effective use was made when interactions were an enrichment of wider curriculum programmes involving traditional learning experiences. He reported these typically involved using videoconferencing to link with special guests or students in different regions of Canada (or the world), for interactive exchanges relating to cultural, historical, political or general curriculum studies. He further claimed best results were gained when students were involved in all aspects of the planning, preparation and production of the videoconferences, citing greater student ownership as promoting higher levels of interest and engagement.

In another example at Australia's University of New England, Smyth (2005) successfully used videoconferencing between campuses for postgraduate professional learning group discussions and peer-mediated presentation of research proposals, as well as engaging students remotely in medical assessments for early intervention. Smyth argues that there are pedagogical issues based on an epistemological view of knowledge that places the teacher at the centre of learning process rather than the learner, which act as major stumbling blocks to a learner-centred approach to videoconference use. She comments that "the immediacy, flexibility and visual richness of the medium as well as its increasing reliability enhances possibilities for learner-centredness and interactive learning", but that for this movement to take place, requires "thoughtfulness, reflection and planning" (p. 809). Smyth's conceptual framework for learner engagement using videoconferencing (Figure 1) provides a matrix to guide such a movement, while at the same time acknowledges

Fit of videoconferencing media to purpose described by example				
		Increasing interactivity and learner-centredness ----->		
Type of interaction				
Instructive pedagogy ----- ↓	One- to-many: Lecturer/student to many in single or multipoint link	Guest lecture of timetabled class; students' accessible presentations; Practical demonstration without interaction	Formal tutorial or class; practical demonstration or practice presentation with asynchronous interaction	Practical demonstration with synchronous interaction; questioning and feedback; study skills tutorial
	One-to-one: Lecturer/student to student in single point link	Remote practicum observation; Oral/practical examinations	Postgraduate supervision; master classes	Student-to-student mentoring; teamwork or collaboration; peer learning
Constructive pedagogy ----- ↓	One-to-some: Lecturer/student to several students in single or multipoint link	Tutorial discussions; dissertation viva; assessment tasks; group observations	Student group leader working with others on joint project; Facilitated discussion; Practical experiments	Students developing presentation skills with self-initiated practice for feedback; teamwork
	Some-to-some: Students to other students in a multipoint link	Project team meeting; group work; postgraduate supervision including cross-institutional collaboration	Teamwork; self-guided real/virtual/practical fieldwork; role plays; project collaborations; discussions	Student-initiated self-help groups; action and professional learning circles; rehearsals; real-time action or problem-based learning

Diagonal arrow indicates increasing student autonomy and control of learning

Figure 1. Smyth's (2005) conceptual framework for learner engagement using videoconferencing.

useful roles for the technology from both instructive and constructive pedagogical stances.

In presenting the framework, Smyth (2005) points out that it does not represent qualitatively different, or increasingly desirable experiences in using videoconferencing. It is intended to illustrate how the technology might be used in a variety of equally valid ways, according to the different purposes afforded it by teachers and students. However, she also comments that downwards diagonal movement towards more student-centred, constructivist-oriented use may now be more possible, due largely to technology and access gains linked to improved affordability and equipment reliability. In the context of this study, Smyth's (2005) framework was useful for informing the development of videoconference practice across the "one-to-many" line, from an approach emphasising instructivist pedagogy (the workshops – far left of model), to one which afforded the possibility of greater levels of student interactivity and participation (the virtual labs – far right of model). However, as the videoconferences progressed, a number of issues revealed themselves about attempting more learner-centered approaches, some of which were unrelated to the technology itself.

Analytical framework

This study adopted principles aligned with Engeström's (1987) Activity Theory framework to explore the influence various factors had on student interaction and perceptions of the effectiveness of the videoconferences, within the wider context of the school-scientist partnership. While not applying the framework in its entirety, the study drew on the principles of tool mediation and contradiction (or tension – Dippe 2006; and resistance – Lim and Hang 2003), to investigate why attempts to engage students more interactively in the workshops and labs, and move teaching practice towards more constructive, student-centred pedagogical models, were largely unsuccessful. Activity Theory has been frequently used to examine the mediating influence of technologies on environments, systems and programmes (Benson, Lawler, and Whitworth 2008; Hardman 2005; Lim and Hang 2003; Murphy and Rodriguez-Manzanares 2007, 2008). However, as Lim and Hang (2003) comment, its potential is much wider than this, allowing "one to observe the actual processes by which activities shape and are shaped by their context" (p. 51). This notion of "contextual effect" was particularly valuable to this study, as it provided a lens through which to observe and analyse how students reacted to the advent of the videoconference workshops and labs, and constructed their perception of their effectiveness and value.

Research context and participants

The researched unit of analysis comprised a series of three videoconference workshops and three virtual labs, involving four scientists and 37 senior secondary school students (Year 13) and their teacher. The scientists worked for a government-owned biomaterials research institute, and the students and teacher attended a single-sex secondary school approximately 500 km to the south of the institute's location. The school was identified through direct contact between the coordinating scientist (Tom) and the school's Head of Science (Sam). Scientists and students were videoconference linked via the Kiwi Advanced Research and Education Network

(KAREN) for the workshops and labs, each lasting approximately one to one and a half hours, and spanning a six-month period.

The videoconferences took place in the first half of the 2010 school year (February–July), and were designed to support students' work towards the National Certificate in Educational Achievement (NCEA level 3) Biotechnology standard 3.6, which:

... requires students to be able to describe two biotechnological applications, two techniques used in each application and the human need or demand for each application. This ability is to be assessed internally. Teachers can choose to do this in a number of ways, such as a research task, a report, a test or a workshop. The applications can be assessed separately and by different methods. One application could be assessed by a research task that incorporates the criteria for AS 90714 (Biology 3.2). The second application could be assessed in a test or as part of internal school examinations. Alternatively, both applications could be assessed in one test at the end of the topic. (Ministry of Education 2006, Bio/3/6_B3, p. 3).

The two biotechnology applications selected for the workshops were transgenesis and gene cloning, while the virtual labs concentrated on plant tissue culturing techniques.

The videoconferences were part of a wider partnership programme the institute had engaged in with the school over the six-month period. Due to distance, other interactions had been facilitated through a combination of email, blogging, online resources, face-to-face school-based labs held by scientists, and teacher visits to the institute. This use of videoconferencing was the first attempt at using synchronous technology to bridge the distance divide, while at the same time attempting to build on the work introduced in the face-to-face labs.

Sam, the participant teacher, was an experienced practitioner with over 25 years teaching experience, while the four institute scientists involved were Charlotte (a senior plant and tissue culture specialist), Liz (a molecular biologist), Maree (a geneticist) and Tom (a GIS specialist). The study was subject to the institute's ethical guidelines for educational research, with informed consent and right of participant withdrawal procedures being followed. In reporting data below, all names and other potential identifiers have been changed to maintain anonymity.

The teaching workshops and virtual labs

Three teaching workshops and three virtual labs were held over the six-month period. Typically, teaching workshops were led by a scientist who made a presentation to the students on a specific aspect of their work, usually focusing on their biotechnology research and illustrating its application through reference to local examples. It was intended for these to be semi-interactive in nature, with the scientist presenting a 30 minute summary supported by Powerpoint slides, followed by a 15–30 minute discussion with the students (Figure 2). Virtual labs were more practical in nature, and took place in an institute laboratory. In these, scientists demonstrated a variety of plant tissue culturing techniques, emphasising specific measures that need to be taken to ensure consistency in result quality. Students were encouraged to ask questions and interact with the scientist during these labs, as well as at their conclusion. As there was only one videoconference system, equipment needed to be transferred to the lab and set up for each session.

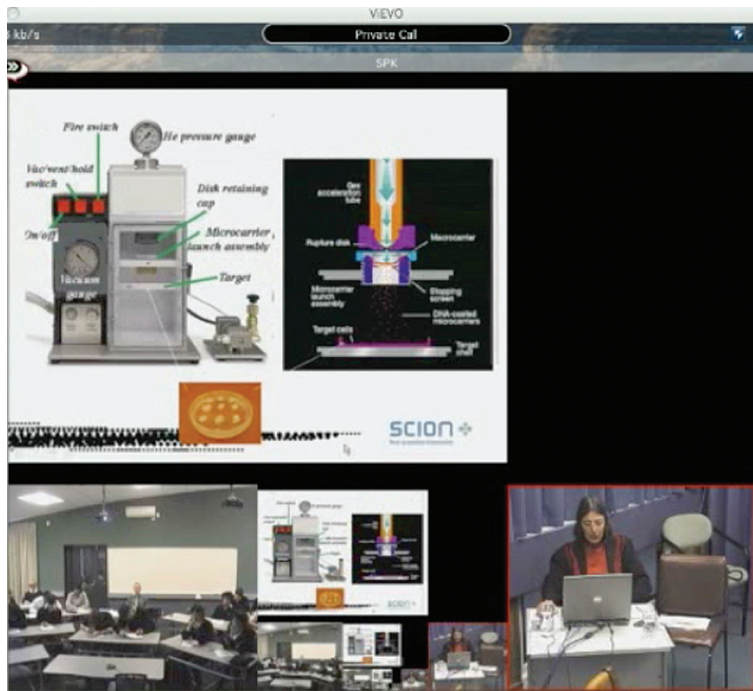


Figure 2. The students, teacher, and scientist participating in a teaching workshop.

Research method and data collection

The research followed an interpretive methodology using a case study approach, and employed mixed method qualitative/quantitative data gathering procedures. These were: a focus group interview with scientists after the videoconferences (Appendix 1); a semi-structured interview with the participant teacher after the videoconferences (Appendix 2); a 5-point Likert scale and short response student questionnaire (87% returned) (Appendix 3); and an interview with a sample of students ($n=9$, students A-I) following the final videoconference lab and questionnaire completion (Appendix 4). Interviews were carried out via audioconference or using the EVO ViEVO IP-based video gateway². All interviews were recorded on a digital notetaker and later transcribed. Transcriptions were made available to participants for verification. Each videoconference was observed and recorded by the researcher through ViEVO from his university office, using IShowU HD screen capture (Figure 2).

Data coding

The researcher photocopied interview transcripts and questionnaires and carried out blind coding with a postgraduate e-Education student. Following Braun and Clarke's (2006) inductive thematic analysis approach, data were independently sorted and organised aligned to the research questions. After an initial appraisal, both coders met and compared coding decisions.

After negotiation and discussion, general agreement was reached on coding classifications based on these themes:

- (1) Students' perceptions of the effectiveness and value of the videoconferences;
- (2) Influences on student interaction and participation in the videoconferences;
- (3) The videoconferences and learning authenticity.

Results

Table 1 summarises responses to the questionnaire regarding student perceptions of the effectiveness and value of the videoconferences (Theme 1). Responses suggest strong support for the teaching workshops (statement 1) and slightly lesser support for the labs (statement 2) as worthwhile learning experiences, with statements 3 and 4 linking these perceptions to the different types of knowledge students gained from the videoconferences. Perhaps not unexpectedly, students placed greater value on knowledge they saw as being directly beneficial to meeting the Achievement Standard (statement 3), while placing less on knowledge they perceived as interesting, but not of immediate relevance to the Standard (statement 4). This support is corroborated by responses to statements 13 and 14, which indicated a majority of students viewed videoconferencing as an effective learning medium, and would support its further use in their studies (approx. 63% and 69% at Likert 4 and 5 respectively).

Consistent with the earlier statements were responses to statement 10. Only just over 34% of students rated the virtual labs as superior to workshops (Likert 4 and 5); the remainder were neutral or registered disagreement with the statement. Student interview data provided insights into reasons for this. When asked to compare the workshops with the labs, while students enjoyed the labs, they did not perceive they learnt as much “useful” knowledge from them as they did from workshops. One student commented:

I thought the labs were great. It was good seeing how scientists really do this stuff, and that it's happening here (in New Zealand) . . . but I'm not sure how useful it will be for the exam. We don't get to do this sort of thing (practical work) for our Standard. (Student G, interview, July 2010).

Teacher comments tended to reinforce this view, citing “Standard coverage” as an overriding measure of value:

. . . of the four segments Charlotte did, the one that she did on making organisms transgenic – like the biolistics part - that fitted in completely with the Standard. Those sections worked in really well. The one that was probably the least useful was cryopreservation as we didn't need to cover this, but it was still interesting and important for Charlotte to talk about it, because it's one of the techniques she uses in her job. (Sam, interview, July, 2010).

Statements 5 and 6 focused on how students perceived the videoconferences added authenticity to their school science (Theme 4), through learning more about the work of scientists and providing a “real world” context to concepts they were learning. A majority (63%), considered the videoconferences enhanced the relevance and authenticity of their school studies (statement 5). Interview data generally linked this more with the virtual labs, where students appreciated having the techniques they had been reading about demonstrated in a live setting, and learning about how they were used in New Zealand research:

. . . the tissue culturing lab was good . . . micropropagation. It was cool to see it actually being done and to learn about how they maintain sterility. We don't have that sort of

Table 1. Student perception of the effectiveness and value of the videoconferences and their content and format as rounded percentages and raw numbers (x).

	1	2	3	4	5	Total responses
1. I consider the videoconference teaching workshops to be worthwhile learning experiences		9.37 (3)	28 (9)	31.25 (10)	31.25 (10)	100 (32)
2. I consider the videoconference 'virtual labs' to be worthwhile learning experiences		15.6 (5)	37.5 (12)	25 (8)	21.8 (7)	100 (32)
3. I developed new science knowledge useful to my studies, through the videoconferences (teaching and labs)		6.25 (2)	25 (8)	43.75 (14)	25 (8)	100 (32)
4. I developed new science knowledge of interest, but not directly related to my studies, through the videoconferences (teaching and labs)		22 (7)	25 (8)	28 (9)	25 (8)	100 (32)
5. The videoconferences added authenticity to the science I am learning at school (teaching and labs)	3 (1)	12.5 (4)	22 (7)	41 (13)	21.9 (7)	100 (32)
6. I developed new knowledge related to the work of scientists, through the videoconferences (teaching and labs)		28.12 (9)	18.75 (6)	34 (11)	18.75 (6)	100 (32)
7. I consider the videoconferences helped further my interest in, or enthusiasm towards, science	6.25 (2)	22 (7)	37.5 (12)	25 (8)	9.37 (3)	100 (32)
8. I found the format of the videoconferences appropriate		25 (8)	28 (9)	21.8 (7)	25 (8)	100 (32)
9. I found the content and the language of the videoconferences was pitched appropriately		15.6 (5)	28 (9)	28 (9)	28 (9)	100 (32)
10. I consider 'virtual labs' superior to the teaching workshops for my learning	6.25 (2)	25 (8)	34 (11)	18.75 (6)	15.6 (5)	100 (32)
11. I could see and hear the videoconferences clearly	12.5 (4)	12.5 (4)	21.8 (7)	18.75 (6)	34.37 (11)	100 (32)
12. I felt confident to contribute to the videoconferences (e.g., through asking questions, offering opinions)	21.8 (7)	18.75 (6)	31.25 (10)	18.75 (6)	9.37 (3)	100 (32)
13. I consider videoconferences to be an effective medium for my learning		9.37 (3)	28.12 (9)	43.75 (14)	18.75 (6)	100 (32)
14. I would like more videoconferences in my courses			31.25 (10)	37.5 (12)	31.25 (10)	100 (32)

Note: Likert ranking 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

gear at school . . . can't really do it here 'cause we don't have the stuff. She (Liz) also talked to us about how it was being used at (institute) for her cloning research. It made what we learn at school more real. (Student C, interview, July 2010).

Of slightly lesser value was learning about the work of scientists (statement 6) – this was rated favourably by 53% of students. Interview data tended to indicate students at this level already held solid concepts of what scientists did and the nature of their work, and the videoconferences served mainly to reinforce, rather than change this. This result is possibly unsurprising, given that these students were year 13s, and had opted for this highly specialist Standard for scholarship-level studies. Also, some indicated they had parents or relatives who were engaged in science work, and that discussions relating to this were commonplace – “my Dad works at Wellington University. He's a research scientist and tells me all about the stuff he does. I think that's why I'm interested in it (science) too.” (Student B, interview, July 2010). This phenomenon could also possibly explain the “lukewarm” response to statement 7, in which only just over 34% indicated the videoconferences furthered their enthusiasm and interest in science.

Of the statements pertaining to more logistical aspects of the videoconferences (8, 9, 11 and 12 – Theme 2), responses to statement 12, and the reasons for these, were somewhat surprising. It revealed that only just over 28% of students felt confident asking questions or making comments during the workshops or labs (Likert 4 and 5). Given the age of the students and their level of study – and that prerequisites to this Standard would have required them to have studied in this area from year 11, their apparent lack of confidence to interact was unanticipated. When asked about this, student reluctance appeared linked to two factors. Firstly, some students felt embarrassed about seeing themselves close up on the large screen, and the way the videoconference system was set up to zoom in on speakers automatically (directional-to-voice), meant this could not be avoided. One student described the experience as, “horrible. I asked a question and the thing (camera) zoomed in on me. I looked awful 'cause I've a bad zit problem . . .” (Student A, interview, July 2010), while another commented, “I don't like everyone seeing me close up” (Student F, interview, July 2010).

Secondly, despite the number of videoconferences, the duration they spanned, and some brief face-to-face scientist-student contact, students appeared uncomfortable to interact for fear of “appearing dumb” in front of the scientists. Student D provided some interesting feedback about this, which was also illustrative of comments other students made,

. . . though it's about the fifth time we've done one (videoconference), it's different to being with the teacher. I don't know her (the scientist) . . . she's an expert. I don't want to say anything 'cause . . . like . . . it could be a really basic question and she might think . . . God, what a thicko (sic). (Student D, interview, July 2010).

Another student commented that he needed time to reflect on the content of the workshops and labs. He remarked that they were fast-paced, and that he was so busy taking notes that he really didn't have time to ask questions, “I was flat out writing stuff down . . . I hardly had time to look up at the screen, let alone think of an intelligent question to ask!” (Student G, interview, July 2010).

Interview data from Sam corroborated student views, but he added that most discussion happened in class after the videoconferences had finished. He appeared surprised by the lack of student interaction during the conferences, but did not consider this lessened their value,

... I think they (the students) got stage fright (laugh). They're not like that usually in class ... they're actually quite a vocal lot. We got some really good stuff out of it though (lab 2), after it had finished! We talked for about half an hour on the techniques and how they're being used in Liz's research. It's really good for the students to see and hear it first hand. (Sam, interview B, July 2010).

While such comments should not be attributed solely to the videoconference medium, and acknowledging the limited number of students interviewed, this result does however suggest some limitations to videoconferencing for forming relationships and creating trustful environments supportive of interaction involving young people and experts, especially when face-to-face opportunities are limited. Further research in this area may be beneficial.

Interview data from scientists also indicated concerns about the lack of student feedback (Theme 2). Some found this disconcerting, and led them to question whether or not students were "taking it in", as they gained few cues from the videoconference upon which to make such judgments. Maree commented:

... they (the students) just sat there most of the time ... nothing! If it hadn't have been for the practice sessions³ beforehand, I would've had no idea if what I was doing was at the right level – too hard, or whatever ... even in the labs it felt as if I was talking to myself ... like some chef on a TV programme! (Maree, focus group, August 2010).

Apart from lack of feedback, scientists' main comments focused on logistical aspects of the videoconferences (Theme 3). Specifically, these related to planning and preparation time, setting up videoconference equipment, and dealing with technical issues. The use model required scientists to be involved in videoconferences with the teacher before each student session, to ensure the level and volume of content being introduced was appropriate and manageable. These sessions also served as trials for the equipment, which the scientists had never used before. While scientists viewed these sessions as valuable, they added considerably to their workload. Tom commented:

... we needed to do them (practice sessions). We're not teachers, and had to make sure what we were doing – especially in the labs – was OK. But they (the videoconferences) took a lot of time. Some of us had to do lots of homework, as it's stuff we haven't done for a while ... and we had to make up the slides. I reckon that probably for each hour or so of workshop, we had to spend six ... probably more ... hours preparing ... plus the practice. (Tom, focus group, August 2010).

Technician support was also needed, especially for the virtual labs, as scientists were not trained in moving and setting up the videoconference equipment. This proved problematic as the scientists' labs had few IP patch points, and a special wireless remote camera needed to be used. Also, the practical nature of virtual labs required more movement, and needed to be choreographed to ensure the camera operator captured the required action. This all added to the time requirement, as Charlotte observed:

It took a lot of practice to get them right (the labs). We almost had to write a script to make sure Phil (the technician) got it all. It's just as well the government's paying for this ... we couldn't afford the time out of our budget. (Charlotte, focus group, August 2010).

Phil, the technician, also needed to attend the videoconferences, to deal with technical issues that arose. Typically these comprised line failure caused by bandwidth fluctuation, and in one instance, replacing a connection cord after one of the scientists tripped over it.

In summary, while data indicates students gained value from the videoconferences, a number of factors influenced their effectiveness, levels of student interaction, and scientists' attempts to use the technology in more interactive and constructive ways. These will now be discussed.

Discussion

Videoconference effectiveness and value

In appraising the effectiveness and value of using videoconferencing for these workshops and labs, results suggest some tension existed between students' preference for the workshops as the most efficient means of gaining content needed for their Standard, and scientists' efforts to move towards more constructive practice through engaging students more interactively in the virtual labs. This tension resulted from two main factors. Firstly, students' preoccupation with content coverage as defined by the Achievement Standard prescription, meant that most of what the videoconferences delivered that fell outside of the Standard was viewed as interesting, but peripheral. While the videoconferences appeared quite useful for supporting affective aspects of students' work – such as authenticity, relevance and the value of science (refer below) – interviews linked these aspects more closely to the virtual labs, where there was less focus on content knowledge and more on demonstrating scientific techniques and the work of scientists. The more highly rated workshops on the other hand focused strongly on science content, and due to the level of prior planning and preparation, their value lay in their tight linking to the Achievement Standard prescription. While one of the aims of the virtual labs was to generate greater interactivity and engagement between the students and scientists, thereby moving videoconference practice towards constructive models (i.e., the right top end of Smyth's framework), tensions brought about by assessment requirements, and a perception of how knowledge useful to meeting these requirements could be most efficiently attained, appeared to work against this.

Secondly, tension existed between school curriculum and organisational systems and conventions, and the flexibility needed to implement the series of videoconferences in a way that could optimise their potential effectiveness. Labs and workshops were constrained by timetables, videoconference room access and physical layout, and “block” teaching practices. They needed to be designed to fit into a one-hour period structure, with just one spanning two periods at just over 90 minutes. Allowing for student settling in and packing up, this meant that most videoconferences lasted approximately 45 minutes, during which time scientists were expected to introduce and deliver the workshop or lab, field questions from students and the teacher, and briefly introduce subsequent sessions. Notwithstanding any technical issues, this compressed timeframe significantly restricted what scientists could achieve, and the level of interaction possible.

In addition, as the videoconference equipment was located in a general-purpose room at the school, sessions needed to be timetabled to coincide with both scheduled class teaching time, and when the room was not booked by other users. This narrowed the available options, and severely restricted the number of videoconferences able to be held over the six months. It also contributed to fragmentation and inefficiency, as scientists needed to spend time revising previous work when there were substantial time lags between sessions. The physical layout of the videoconference

room was similar to a standard classroom, with desks in curved rows and a large flat screen at the front. Some students reported difficulties in viewing the LCD screen from seats at the side, and due to the number of students and relatively small room size, alternative seating options were limited. This appeared to compromise the quality of the experience for a minority but still significant number of students, as illustrated by responses to questionnaire statement 11.

Influences on student interaction and participation

Data indicates a lack of student confidence to interact during the videoconferences. Almost 40% indicated they did not feel confident to ask questions or interact with the scientists, with another 31% rating this as neutral (statement 12). Reasons for this seem to relate to a limitation of videoconferencing for establishing a psychologically safe environment for these students. Results suggest a mediating effect of videoconferencing which may, to some extent, have influenced the establishment of a trustful relationship between the scientists and the students – such as that established between students and their teacher as a prerequisite for effective learning. Despite the best efforts of scientists to engage with students and a reasonably substantial number of sessions, this mediating effect did not appear to diminish.

Student feedback suggested a level of tension when using videoconferencing. Some commented on physical self-consciousness about seeing themselves on the large screen, while others indicated embarrassment for fear of appearing “dumb” in front of the scientists, whom they considered might be judgmental. Teacher data corroborated this, indicating the most valuable discussion occurred after videoconferences had finished. Whilst acknowledging the limitations of this trial, this does suggest more work needed to be done by the scientists to develop relationships with students, possibly through greater face-to-face contact in the programme’s initial stages. Videoconferencing appeared to have limited success as a relationship-establishment medium during this trial.

The videoconferences and learning authenticity

Although costly, videoconferencing in this trial proved an effective means of linking students with scientists, in a way that introduced them to current science knowledge, research and practice, and illustrated concepts they were learning. Authenticity was enhanced by exposure to New Zealand examples, and heightened awareness that what students were learning at school had relevance to their likely future study and work. While assessment knowledge concerns were paramount, students understood the value of the videoconferences for accessing expert knowledge beyond this, which they would otherwise have been unable to tap into. Although the videoconferences did not appear to make much impact on furthering students’ enthusiasm towards science or their knowledge of the work of scientists, this may be because by year 13 such perspectives and knowledge are already well developed. Such a conclusion would be reasonable, given the commitment year 13 students would have already demonstrated towards science, to study successfully to that level. Some students also indicated they had family or relatives engaged in science careers, which would have further consolidated this understanding. While perhaps not the students’ main

priority, the authenticity and relevance enabled by the videoconferences enhanced their learning by linking more theoretical school study with practical, local, leading-edge science examples.

Conclusion

This study detailed senior secondary students' perceptions of the effectiveness and value of videoconferencing as a medium for interacting with research scientists during a six-month school-scientist partnership; and identified issues in using videoconferencing to bring highly specialised "virtual experiences" to the classroom. It drew on Activity Theory principles of contradiction (tension) and tool mediation, in exploring factors that influenced student perceptions and reasons for their reluctance to interact during the videoconferences. It also exposed the challenges presented to scientists wishing to evolve their videoconference practice towards models based on more constructive pedagogies.

Reflecting upon Smyth's (2005) framework, substantial challenges exist to using videoconferencing designed around constructive and interactive models, to connect students with external experts or experiences in one-to-many scenarios. These challenges include dealing with the mediating effect of videoconferencing on relationship formation, the amount of planning and preparation time needed, and evolving curriculum and assessment design to more closely align with the capabilities of the medium. As Internet Protocol desktop systems, Web 2.0 video-based collaborative tools, and high-speed data networks become commonplace, using videoconferencing to synchronously connect students to knowledge and experience worldwide will become a viable option for many schools.

Notes

1. Detailed information on NCEA can be found at http://www2.careers.govt.nz/how_to_understand_ncea.html
2. Please refer: <http://evo.caltech.edu/evoGate/>
3. Prior to each workshop and lab, the scientists held a practice session with teachers to ensure content and level of material were appropriate.

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Appendix 1.

Scientist focus group (semi-structured)

Interview starter questions

Additional questions to be generated according to responses

(Introduce, thank, brief on recording procedure, data use, confidentiality, anonymity etc.)

- (1) How did you come to be involved in the videoconference workshops and labs?
- (2) Why did you agree to participate? (have you done anything like this before?)
- (3) Can you talk a bit about the preparation you needed to do to before the workshops and labs?
- (4) Overall, what is your opinion of how well they went? (how do you know?)
- (5) As presenters, were there any issues for you when delivering your workshops and/or labs? (explain and describe)
- (6) Do you consider videoconferencing to be an effective medium for delivering content and practical demonstrations to students? (explain and describe)
- (7) What did you as scientists get out of the experience? (explain and describe)
- (8) What do you think the students got out of the experience? (explain and describe)
- (9) Thinking more broadly would you consider participating in these on a wider scale a viable option for you? (more schools, broader science).

Thank you for your time. I will send you a copy of the interview to check once it has been transcribed.

Appendix 2.

Participant teacher interview questions (semi-structured)

Starter questions

Additional questions will be asked according to responses

(Introduce, thank, brief on recording procedure, data use, confidentiality, anonymity etc.)

- (1) How did you and your class come to be involved in this programme (Science-for-Life)?
- (2) Can you tell me your reasons for linking with (institute) for this series of videoconferences? (explain and describe aims and goals)
Were your goals and objectives met? (how? how do you know?)
- (3) Can you describe the preparation that went on at your end for the videoconference workshops and labs?
- (4) What do you think your students got out of the videoconferences (workshops and labs)?
Were you happy with your students' performance? (explain and describe).
- (5) Did you follow up on the content of the videoconferences in class? (how, and in what way?)
- (6) Were there aspects of the videoconferences you felt might have been improved? (explain and describe)
- (7) What do you consider to be benefits of using videoconferencing in this way? (explain and describe). Any limitations? (explain and describe).
- (8) The workshops and labs had quite different purposes and approaches. Can you comment on the value and success of each, and any issues you consider affected this?

Thank you for your time. I will send you a copy of the interview to check once it has been transcribed.

Appendix 3.

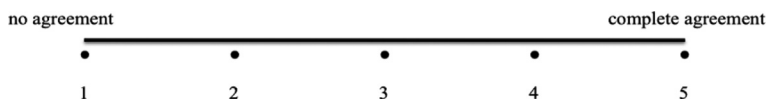
Student Questionnaire

Science-for-Life Videoconference Workshops and Labs

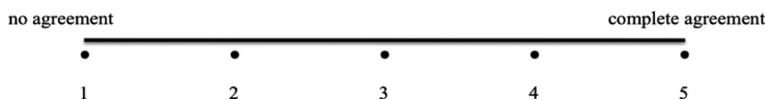
Please indicate your response to the following statements relating to your experiences in the (institute) videoconference workshops and labs.

For all statements, a ranking of 5 means complete agreement, while a ranking of 1 means no agreement.

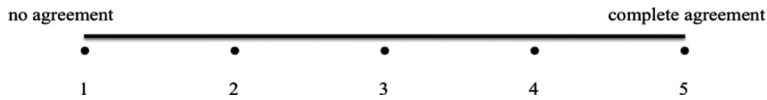
- (1) I consider the videoconference **teaching workshops** to be worthwhile learning experiences



- (2) I consider the videoconference '**virtual labs**' to be worthwhile learning experiences

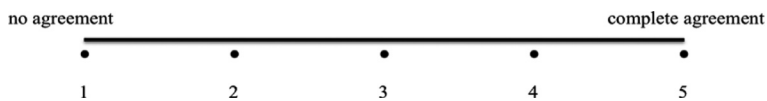


- (3) I developed new science knowledge useful to my studies, through the videoconferences (teaching and labs)



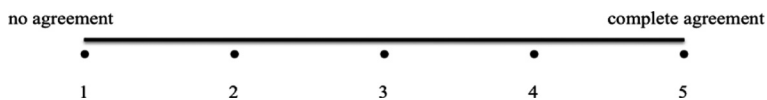
Please detail briefly what this was:

- (4) I developed new science knowledge of interest, but not directly related to my studies, through the videoconferences (teaching and labs)

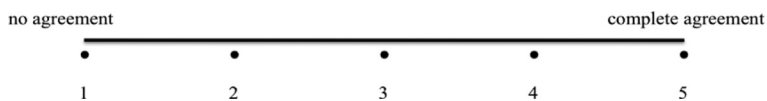


Please detail briefly what this was:

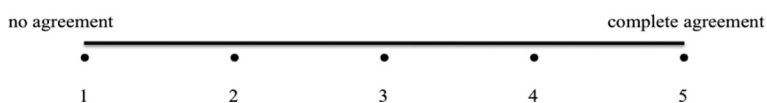
- (5) The videoconferences added authenticity to the science I am learning at school (teaching and labs)



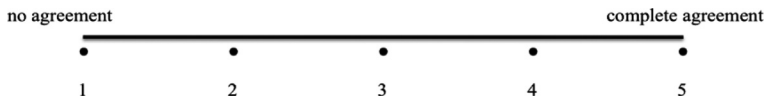
- (6) I developed new knowledge related to the work of scientists, through the videoconferences (teaching and labs)



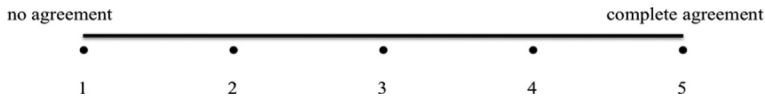
- (7) I consider the videoconference helped further my interest in, or enthusiasm towards, science



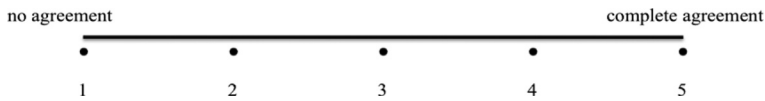
(8) I found the format of the videoconferences appropriate



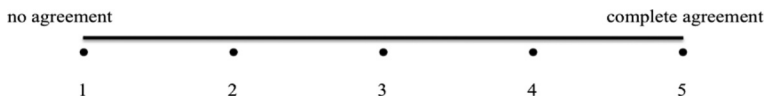
(9) I found the content and language of the videoconferences was pitched appropriately



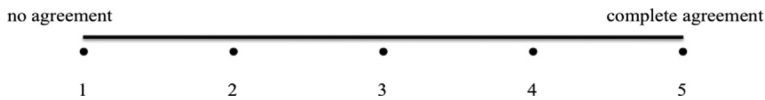
(10) I consider 'virtual labs' superior to the teaching workshops for my learning



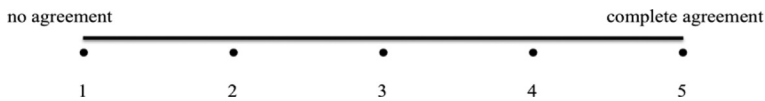
(11) I could see and hear the videoconferences clearly



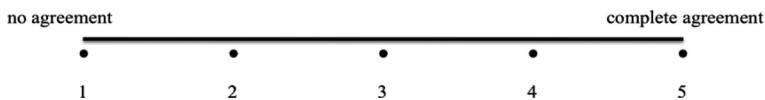
(12) I felt confident to contribute to the videoconferences (e.g., through asking questions, offering opinions)



(13) I consider videoconferences to be an effective medium for my learning



(14) I would like more videoconferences in my courses



Appendix 4.

Student interview schedule (semi-structured) following questionnaire

Starter questions

Additional questions will be asked according to responses

(Introduce, thank, brief on recording procedure, data use, confidentiality, anonymity etc.)

- (1) Firstly, do you think the videoconferences were worthwhile? (Separate – workshops, virtual labs). Why or why not? (Elaborate and expand)
- (2) What sort of things did you learn from them that you found useful? (if necessary, introduce by discussing differences in questionnaire results between study-related and

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other knowledge, ideas around authenticity, understanding of science and work of scientists etc.) Elaborate and expand as appropriate.

- (3) Results from the questionnaire generally suggest students found the teaching workshops more valuable than the virtual labs. Can you tell me something about that?
- (4) Results from the questionnaire suggest students didn't feel that confident to ask questions or interact with scientists during the workshops and labs. Can you tell me why that might have been? (Elaborate and expand) (Talk briefly about teacher comment that most useful discussion happened following each conference)
- (5) From your point of view, how might the videoconferences have been improved? (prompts: interaction, technical, content, pace, volume/clarity, room layout etc.)
- (6) Overall, do you think videoconferencing is an effective way for you to learn? (how, why/not etc.)

Thank you for your time. I will send you a copy of the interview to check once it has been transcribed.