The Teacher’s Laptop as a Hub for Learning in the Classroom

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Abstract

This article presents data from a longitudinal study of the effects of providing teachers with personal laptop computers. It considers the role of teacher laptops in learning and teaching in three schools selected because technology was widely used there. Using multiple methods of data collection (observation in classrooms; interviews with teachers, leaders, and students; and document-file analysis), the authors investigated the conditions surrounding the infusion of the laptop into all aspects of teacher practice, including, critically, practice in the classroom. The examination of classroom practice illustrated how one computer came to act as a hub for a variety of other digital technology use. (Keywords: digital technologies, teacher practice, teacher laptops, elementary education)

The vision of digital technologies as embedded classroom tools has long remained elusive. Despite increased access to technology for students (Johnson, Kazakov, & Svehla, 2005), there appears to have been little change to the learning and teaching practices in many classrooms (Cox et al., 2003a, 2003b; Hayes, 2007). Integration—the vision where technology is a seamless part of the educational environment, providing support for the type of learning experiences that engage students and are meaningful, relevant, and intellectually stimulating (Bransford, Brown, & Cocking, 2003)—is not widely apparent (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010). Although technology use in schools has increased, it has remained limited in terms of students’ school activities and experiences, both with respect to time and to nature of use (Bakia, Yang, & Mitchell, 2008; Becker, 2001).

The information and communication technology (ICT) policies of international education authorities have attempted to address issues associated with the relative lack of successful integration into school settings. They have considered some of the contextual and personal features that research has shown to mediate use, such as proficiency with technology, beliefs about its value and how it sits with personal notions of teaching, and contextual factors such as access and support (e.g. Straub, 2009; Windschitl & Sahl, 2002).
One such policy is the Laptops for Teachers (TELA) initiative in New Zealand. Under this scheme, the New Zealand government pays two-thirds of the cost of a laptop for every teacher. Either the school or the teachers themselves pay the balance. The authors gathered the data discussed in this article as part of a wider evaluation of the TELA initiative.

A key objective of the TELA initiative was to increase the confidence and competence of teachers in the use of digital technologies in all aspects of their professional lives, including learning and teaching, classroom management, and administration (New Zealand Ministry of Education, 2005). We considered that one indication of successful influence of the laptop policy, arising from increased teacher confidence and skill could be to increase the use of other digital technologies by both teachers and students, leading to the type of seamless integration described in policy discourse.

In this article, we specifically examine the influence that introducing government-subsidized laptops for teachers has had on learning and teaching in three New Zealand primary schools (children in Years 1–8 of schooling, ages 5–13) as one possible solution to increase integration. Teachers’ current practice (after Robinson, 1993) is seen as their best solution to achieving their aims for their students’ learning. We describe how the laptops became a central part of the solution to an issue of practice within each school. More specifically, we illustrate how the teachers’ laptops became a hub for technology-supported learning in these schools.

By using problem-based methodology (Robinson, 1993) as a conceptual framework for viewing our data, we were able to link teachers’ use of their laptops and other technologies to the learning context within which they were working. In particular, we considered technologies in relation to each school’s vision for learning and to specifically identified problems of practice. The data show how, in these classrooms, technology-supported learning was situated within a clearly defined vision for learning and shared understandings of the needs of students in each school.

This study provides a snapshot of what is possible when technology is infused through practice that is determined by recognized student need. It highlights how important it is for technology to become a seamless and invisible part of a wider set of learning tools instead of differentiated as something additional. The laptops appear to have played an integral part in enabling such seamless integration.

Research and the Infusion of Digital Technologies
The literature related to the use of ICT in schools is extensive. We focus on literature that suggests reasons why ICT has been less successfully integrated into schools than it has into the wider lives of students and examine why the potential to transform learning and teaching has been realized in only a few pathfinder schools and classrooms. There is sufficient evidence (e.g., Crooks, Harrison, Farringston-Flint, Tomas, & Underwood, 2010) to suggest that,
in certain contexts, it is possible for ICT to be integrated in ways that help prepare students for the 21st century.

The list of reasons the literature offers to explain patterns of use “includes virtually everything about the school and technology” (Zhao, Pugh, Sheldon, & Byers, 2002, p. 484). At the school level, these include leadership support for use (Dawson & Rakes, 2003) and the support of peers (Cooley, 2001). In addition, the provision of technical support has been shown to influence use (Grimes & Warschauer, 2008) to the extent that such support predicts the frequency of use (Dexter, Anderson, & Ronnkvist, 2002).

At the teacher level, research has cited beliefs as a key factor influencing the integration of computers (Lei & Zhao, 2008; Wozney, Venkatesh, & Abrami, 2006). Beliefs also influence the amount of teacher use in the classroom (Ertmer, 2005; Sclater, Sicoly, Abrami, & Wade, 2006). Additionally, teachers’ readiness in terms of knowledge, skills, and confidence to use technology relates to the likelihood of integration (Inan & Lowther, 2010; Ward & Parr, 2010). Teachers with greater skills use technology more often and in a wider range of ways (e.g., Ronnkvist, Dexter, & Anderson, 2000). Further, knowledge and skill are needed to plan and implement effective lessons with technology to support curriculum learning (Dawson, Cavanaugh, & Ritzhaupt, 2008; Donovan, Hartley, & Strudler, 2007).

Professional development that supports the acquisition of not only skills, but also knowledge and confidence, is therefore critical. However, Zhao, Pugh, Sheldon, and Byers (2002) found “serious problems” with much of the professional development offered. Most professional development took the somewhat narrow view that teachers need only technical skills and a good attitude. In their view, few programs pay attention to the pedagogical or curricular content necessary for integration.

A model of technology immersion (Shapley et al., 2010) has encapsulated and empirically tested the relationship between school support mechanisms and teachers’ personal and classroom change with respect to technology. These authors argue that effective technology use demands a comprehensive approach, including robust access, technical and pedagogical support, coherent professional development coupled with effective leadership, and curricula and assessment resources. The model showed that technological immersion had a positive effect on growth in technological proficiency (more than double the rate of controls) and professional productivity as well as on teacher beliefs about technology integration. Over time, teachers became more positive toward innovative practices and student-centred instruction. The classroom immersion indices were predicted by a school culture of innovation, community support, and some of the measures of professional development quality. However, although the frequency of student classroom activities using technology increased, they were still at only a relatively low level of use (once or twice a month). The research informing this technology immersion model adds weight to the idea that it takes both support and
time to embed new technologies fully and comfortably, and that time to play with technology and develop confidence is essential for teachers (Goodwyn, Protopsaltis, & Fuller, 2009).

The Apple Classrooms of Tomorrow project (http://www.apple.com/educ/k12) found that teachers need approximately three years to reach the comfort stage. However, Soloway (2002, cited in Power & Thomas, 2007) suggested the time could be reduced to one-half or even one-third of this with access to portable devices. Ready access and the development and the fact that this is likely to encourage the development of a sufficient level of skill correlate to an increased likelihood that teachers will use a computer as a productivity tool in their professional lives (Shapley et al., 2002, cited in Shapley et al., 2010). One means of ensuring access so that teachers can engage readily with technology and enhance their knowledge and skills with “anytime, anywhere professional learning” has involved providing portable computers to teachers (Power & Thomas, 2007, p. 376).

**Research Method**

The qualitative study this article describes was embedded within a 4-year longitudinal evaluation of the impact of the provision of teacher laptops on teacher confidence, skill, and professional practice. The purpose of the evaluation was to consider the interplay of teachers’ laptop use with other school factors. The New Zealand Ministry of Education wanted to know how providing laptops for teachers impacted on teacher professional practices and student learning.

We used multiple data collection methods in the larger evaluation study as we documented attitudes and use by teachers (max $N = 349$) in a sample of schools ($N = 14$), over time (see Parr & Ward, 2010). These methods included surveys, teacher logs, and interviews with individuals, groups of teachers, and school leaders, as well as classroom observations. During the evaluation it became clear there was sufficient evidence of the integration of the laptops into teacher practice to warrant a qualitative research study focused on understanding this integration and providing a richer narrative of classroom practice to amplify the longitudinal evaluation data where self-report dominated.

We selected participant schools with the intention of providing a cross-section of schools in terms of decile (socio-economic status of area from which schools draw students), size, and type (contributing, full primary and intermediate). We compiled a list of 20 schools from information about the number of teachers who had initially taken up the ministry’s offer for laptops at schools. The criteria for this shortlist were a school that had more than 10 teachers with laptops and was within relatively easy access for the evaluation team. We selected a range of school types (intermediate, contributing and full primaries), and 13 agreed to participate. The 13 schools covered the full range of socio-economic status groupings (deciles 1–10) in New Zealand, and the roll sizes ranged from 154 to 911 students.
They included urban and semi-rural schools. The final sample includes two intermediates (Years 7 and 8 of schooling).

In this article, we consider data from an in-depth examination of laptop use in three schools. We collected these data in the final year of the evaluation, largely through observation and interview, but with some consideration of artefacts such as documents, computer files, or student work. The purpose of these case studies was specifically to consider the role of the laptops in the daily learning and teaching practices occurring in classrooms within each school.

The Participants

We selected the three case-study schools from the wider sample in the evaluation as schools we had discerned from reports (through surveys and teacher logs or teacher group interviews in the first 2 years of the research) that the laptops and other technology were likely to be embedded in the school. They included an urban full primary school (Years 1 to 8) that was in the lowest socio-economic category nationally. This school (School 1) had 464 students in Years 1 to 6 and 28 teachers, of whom 17 had joined the laptop scheme. The second school (School 2) had a roll of 316 students and 16 teachers, of whom 13 had laptops. It was a semi-rural full primary school (Years 1–8) on the fringe of a city that was of middle to upper socio-economic ranking. The third school (School 3) was a large intermediate school (911 students in Years 7 and 8, ages 11–13) with a staff of 49, 26 of whom were part of the laptop scheme. This school draws students from a high socio-economic area of the city.

We selected three classrooms within each school to represent the age range of children in the primary sector. These had been recommended by senior leaders as classrooms where teachers and students consistently used technology to support learning. We invited the teachers to participate, and they agreed to do so. We also obtained appropriate consent from the parents of the students involved.

Table 1 summarizes the participants from each case study.

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Notes.

- Our discussions with these two principals were both informal and lasted approximately 15 minutes.
- We formally interviewed a group of senior teachers, including the deputy and assistant principal, during the visit to this school.
- We spoke to some of these students informally during class; we more formally interviewed others in focus groups.
**Research Questions**
We derived the research questions for this study from the findings of the evaluation, within which the study was embedded. During the evaluation it had become clear that teachers had increasing difficulty bringing to conscious awareness (in order to report to us) the range of way they used their laptops. Rather the laptop had become an invisible, necessary tool in their professional lives. We wished to understand further the extent to which the laptop had become an integral part of the wider learning activities in their classrooms. Our intention was to find out from observation and questioning the learning and teaching activities within classrooms and then to back-map from these activities to consider the role, if any, of the teacher laptop and how it had influenced their practice and the experiences of their students. The specific research questions were:

1. How and why is the teacher using technology to enrich/enhance the learning of students?
2. How is the teacher using the laptop being to plan and develop observed learning activities?
3. How is the laptop being used during observed classroom activities, including student use of technology?
4. How has the laptop influenced the way students experience learning, either directly or indirectly?
5. What is the learning context within which the laptops are being used in each school?

**Procedure**
We made a 2- or 3-day visit to each of the schools to observe in the three classrooms and talk with teachers and their students about the use of technology we were seeing in these classrooms. The nature of our visit was determined by the school and varied in terms of formality and to whom we were able to speak. In all instances, we were given ready access to classrooms and students to observe practice with technology.

We visited the classrooms of each of the three nominated teachers from each school (nine classrooms in total). Each classroom observation was approximately 60 minutes in length (some visits were longer), depending on what was occurring in the classroom at the time and the extent to which we had already spoken to students from that classroom. The teachers who participated were predominantly female; they ranged in experience from a first-year teacher to highly experienced teachers with 20+ years of experience. We did not collect specific demographic data on the teachers involved in this study.

The study had the approval of our institution’s ethics committee. Thus, we asked the students we formally interviewed if it was OK to talk to them, and we indicated what it was about. They signed consent forms giving consent, except where the school asked to inform parents that we would be visiting their
child’s classroom. Parents could then choose to indicate that the child not be included in our interchanges. None did so. The school principal signed a consent form allowing access to the site and for an interview, and the invited teachers also gave informed written consent.

We conducted formal group interviews with students in each school. We also talked to a number of students informally during our classroom observations. Where possible, we asked students to show us samples of their work and tell us about the process of creation. We interviewed teachers in these classrooms about their learning and experiences with respect to technology, as well as about the classroom events we had observed. We also conducted semi-structured interviews to discuss technology in the school and the teacher laptop program with both the technology leader and the principal in each school. We obtained samples of student assignments and work and took details of blog sites. We made copies of page dumps from the laptops to examine how teachers organized their laptops and as an indicator of the range and extent of use. We also compiled an inventory of available technology and obtained copies of any policies pertaining to technology use.

Each of the formal interviews was approximately 40 minutes in length, and our informal discussions ranged from a few minutes in class to 20 minutes. The length of the informal discussions and access to students were dependent on the classroom teachers and what was occurring at the time in their classes.

**Analyses**

The central ideas and themes discussed in subsequent sections emerged from the data from the three schools and their classrooms through a constant comparative analysis process (Glaser, 1965). This process involved both authors crosschecking one another’s inferences, as each had been present at observations and interviews. As an initial step, at the end of each day of observation, we reviewed our field notes and discussed emergent themes and ideas. We then undertook a systematic, summative analysis of the data from across the three cases to look for similarities and differences in how the teachers had used their laptops in learning and teaching practices and in the environments within which they used them. We then considered the resulting themes in relation to those we distilled from the survey data from the wider evaluation and further consolidated through the information obtained from previous group interviews and teacher logs in the selected schools.

We used key ideas from problem-based methodology (Robinson, 1993) as a conceptual framework for viewing the thematic data we gathered through the process described above. Within this methodology, we view practice as a solution to a problem within a given context and set of constraints. Thus, we discuss the way each of these schools responded to student need (the problem or issue) through the use of technology (the solution or practice), considering the influence of laptop use on classroom practice and considering the enablers of that use.
Findings

In this section, first we describe how the use of technology we observed in each school arose from their vision for learning and the recognized needs of their students—how it was their solution to a problem of practice. We then describe this use, clustering the relevant themes around two intersecting dimensions. The first dimension is the notion of the laptop as the hub for varying forms of digital learning. The themes associated with this dimension include the link to other forms of digital learning and how the laptops function as a centralized planning agency. The second dimension includes themes that represent learning experiences emanating from the hub and its satellites. Finally, we consider the context within which the described use has been made possible—how the constraints on practice have been addressed so that the integration of technology is a viable solution to attain the school and teachers’ desired learning outcomes for students. We drew the direct quotes from across the participants in the respective schools.

Enacting a Philosophy of Education and Responding to Student Need

Each of the three schools had a clearly articulated vision and set of goals for learning and teaching. These goals appear to have been based on the context and culture of the school community. In School 1, where a high proportion of students or their parents had English as an additional language (EAL), the focus was on improving oral language. In School 2, the emphasis was on enriching normal school learning experiences, and School 3 viewed technology as having affordances in terms of implementing the school’s philosophy of invitational learning. The extent to which each school’s vision was innovative varied greatly, but none was static—that is, practice in each school was shifting and changing in some way from what it had been in the past. In all three schools, the use of technology was directly related to both the clearly articulated student achievement goals and a clearly articulated philosophy of learning.

The use of technology to support the philosophy of learning and teaching was particularly evident in School 3. Here there was a complex interweaving of the notion of invitational learning—learning that is personalized and individualized—as a core underpinning principle of learning and instruction in the school, and the pervasive use of technology. The underpinning belief in School 3 is that “kids will run to school excited about their learning.”

The senior management articulated a philosophy of innovation: “An innovative paradigm, that’s what we are on about here. It’s about creating knowledge or using knowledge to create your understanding of the world.” The technology and the systems (or the de-systemizing and alternative structures with regard to organizing the school day or instruction within classrooms) were designed to support such a view of learning. There seemed to be a complex synergy between their view of learning and the use of technology.

There was also an understanding in School 3 that there was a solid theoretical base behind articulated ideas of student learning and that teachers
had to work at it to turn the theoretical into practice. As one teacher explained, it is up to them “how we are going to teach practically using these ideas and this technology....”

We asked whether technology had made invitational learning possible or whether invitational learning had provided an appropriate framework within which to use the potential of technology. We did not get a clear response to this question, but it would seem that the two were being developed in tandem in many ways and that any attempt to define causality would be meaningless.

At School 2, the emphasis was on enrichment of the usual school learning experience, particularly through the use of different media. A push–pull effect was obvious at this school, with the “students pushing and the teachers having to know.” The 6- and 7-year-olds we interviewed were quite clear that they learnt “some off the computer and some our teacher has been telling us about.” These youngsters used electronic and print sources of information.

One said, “Usually when I go home, I go on Kids Astronomy … and I get out books about planets.”

This particular group were fired up about astronomy. They were able to tell us a number of things they had learnt about the planets (they could name them in order) and about why the moon “goes into a banana shape or is only a half one.” They knew how to learn using technology: “When we want to learn about a planet, we just click on it, and we go down, and it tells us something that we don’t know about space.” The use of technology was unforced and clearly provided enrichment for these students.

At School 1, with the high incidence of EAL, there was a clearly identified oral language problem, particularly relating to the range and nature of vocabulary necessary to interact with the curriculum. In this context, the school was using technology purposefully as part of the solution to this issue. All of the examples we saw of technology use had some element of oral language, whether it was the Year 1 students practicing oral language or the Year 3 students explaining mathematics concepts while being recorded. The key underpinning philosophy was that teaching is empowered when the learner is more engaged and independent. There was also a belief that students were more likely to “complete a technology learning task [than a traditional paper and pencil one] because they can view their work, review their work, and be more involved in the process.” This school recognized that they were at a point where technology was seen as a “tool to make teaching more powerful.”

As further evidence that this view of technology was a way of enacting a philosophy of learning or responding to student need, the school used technology where appropriate and for specific learning purposes. It was not an extra activity outside of learning and teaching. A teacher from School 2 articulated this when she explained that “ICT doesn’t sit out on its own; it’s part and parcel of our learning…. Some days it sits out here, and other days it sits right at the core.” The teacher laptops had become an integral part of the infrastructure of each of the three schools, particularly in terms
of classroom practice as the teachers sought to enact their vision for learning for their students. The dimensions of use discerned across these schools relate first to the laptop as a hub for other digital media in learning and to the nature of the various learning experiences that emanated from the hub and its satellites.

The Laptop as Hub for Digital Learning

The first dimension concerns use where the teacher laptops acted as the hub through which a range of learning and teaching activities and other resources were managed and connected. The idea of a hub suggests a lynchpin—something through which activity is routed—and laptops had certainly come to be regarded as central to teacher practice in these schools. Such uses included providing immediate links to a range of software and other resources, providing links to other people through e-mail and the Internet, connecting to other infrastructure, and extending the classroom through greater access and usability. Although these uses were mostly concerned with the delivery of lessons, the laptops also enabled increased efficiency in planning and preparation.

Linking and connecting. Teachers often described how their laptop was an entry point to using a variety of other tools and resources and how there was more freedom for them to work from a variety of places and at different times. One teacher at School 3 stated that s/he did:

…all my work at home on my laptop, and then I plug it in the network and just copy it to our network files. I’ve got, um, [Smart Board] software on my laptop, so if I want to use something that I’ve devised, then I can do that at home. It enables extended work … spend a lot of time globally looking for stuff…

The laptop was often described as the link between different learning locations; it did not matter where the class was physically. As a teacher at School 2 described, all of the unit and lesson plans were on the laptop with hyperlinks to other documents and resources. No matter where s/he was, s/he simply plugged the laptop into the network and had the whole lesson ready to screen through the data projector; the laptop provided for preparation and planning, sharing of key lesson resources, and the type of delivery notes usually written onto a blackboard. Teachers frequently mentioned this notion of the laptop as a place for storing material either directly or through the network, particularly in relation to retrieval of material in different locations.

Active repositories of student work. Another form of connection that the teacher laptops facilitated was a link to archives of student work. This repository included electronic portfolios, working documents, and photographic records of activities. The students also archived their work and retained it as a resource, and often published documents, such as collections of student writing, could be found in the school library or in classrooms.
In School 2, we viewed examples of students that had a permanent record (on CD) of their experiences at camp, including a CD of photos sent by a biologist in Antarctica, with whom students had corresponded when researching that continent. They also had very detailed electronic folders containing examples of work completed throughout the year, and even very young students displayed a thorough knowledge of what these folders contained and exactly how to retrieve anything contained within them.

Likewise, School 1 stored folders of student work on the school intranet. This enabled a teacher to ask a student if the class could look at a published piece and use it as a reading text and allowed students to revisit their own work in their own time and at their own pace to consolidate learning.

A teacher in School 3 discussed individual student blogs, their content, and potential uses, including students using their blogs as showcases and the teacher using it as an exemplar or resource:

If they’ve done a particularly good thing … I can use it with my next class and say, “Can we improve on this?” So then again, it’s the total constructive work and … it’s not all my voice.

In this school, as much of the students’ work was retained on their individual blogs, they and others could return often to their work and refer to it in different contexts.

Planning, preparation, and delivery. At times, the laptops may have had an indirect influence on professional practice, such as in the planning and preparation of lessons. Using the laptop for planning seemed almost too automatic to warrant mentioning, but on questioning, it was clear that all teachers used the laptop to plan—some only for longer-term planning, and some for day-to-day planning. At School 2, a template was set up for planning. The teacher leader worked with teachers initially to put their planning onto the laptop “down to where our literacy and numeracy plans are all on the laptop, and you just have to highlight what it is you’re teaching now.” School 1 had an intranet with all the school policies and resources for every single curriculum area.

You can get AOs [achievement objectives]—just everything you want on all those, the school songs, everything, absolutely everything on there. That’s how you can learn [to use the laptop]. Just little things like that make a difference…. All planning is on there…. You can book the computer room….

Teachers in School 3 also talked of “having everything at your fingertips…. It’s all there for you, you know exactly what to do … and it’s nice because you can add to lessons every year and make them, better.”

In two schools (2 and 1), we noticed teachers using the laptop to record their ongoing assessments of students. Teachers described how their laptops were on their desks and how they recorded observations directly onto them.
about individual students. One reported that if, during the course of teaching, a child did not understand forward number sequence, for example, s/he would quickly type this into the mathematics plan:

So the plan ... evolves. Planning becomes much more focused; in fact, teaching and learning have because I am able to hone in a lot quicker ... whereas in the past, I may have made a mental note of it and maybe remembered next time....

At School 1, the new-entrant (kindergarten) students spoke into the laptop as they practiced positional language, which enabled the teacher to record their oral language as a means of recording the learning as well as developing an authentic resource to share with other students (discussed later).

**Learning Experiences Emanating from the Hub**

Teachers in all three schools used technology in diverse and exciting ways to extend students’ learning experiences. This section illustrates a range of examples of the functions it served and the activities undertaken to highlight the breadth and depth of use in the three school contexts.

*Personalized resource for students.* Technology in these schools provided the students with access to a range of resources and other infrastructural support materials to undertake their class work. The most obvious examples of anytime infrastructural support for students were in School 3, but in all three schools, technology was highly accessible to students.

In School 3, where the philosophy involved invitational learning and where the students were older (11–13 years), students could use photocopiers, iPods, cameras, various computer editing suites, and even teacher resources without supervision. Furthermore, they could go into any classroom at any time to work with resources or go to the library when they needed to. We observed more than one student ask a teacher (not their own) if they could use the computers in his/her classroom even when a class was present. We also observed a lesson where students were working in three different locations, depending on their current task. Further, iPods enabled them to access the Internet outside the classroom walls.

A different take on the notion of technology providing the anytime support described above is that of differentiating and/or personalizing learning. All teachers and students interviewed in the case study schools gave detailed examples of how they use the Internet in their classrooms to provide material to support more individualized learning and teaching. In School 3, students log into an Australian-based maths system (Mathletics), where the classroom teacher sets a course that students can study online at their own level. At the end of the course, they can join a live competition with students from around the world who are at their level. Students stated that they liked the interactive website because it involved real people as well as learning.
Similarly, at School 2, we observed a Year 3 numeracy lesson where students were working on different online activities, dependent on their capability. Of particular note in this lesson was the way a student with special needs was able to work alongside the other students on an activity at his/her level, with no apparent difference from peers in the way s/he was treated or the way s/he was working.

A teacher in School 3 described another example of individualizing learning and using technology to manage it. In this class, students looked at the desired learning outcomes for a particular unit, then chose the class workshops they needed to attend. “In any one day, there could be ten kids working on completely different learning intentions while I work with a workshop group … only the kids that need to be there,” the teacher described. One of the examples s/he provided was the teaching of speech making. If students felt confident in the work they were doing or where students needed to “brush up on certain things,” they were able to listen to downloaded podcasts of speeches of famous people (using a site called T Talks) that the teacher put on their iPods. They could go out of class with an iPod and continue working on their speech while other students were in a workshop with the teacher. At times, if working with a bigger group, the teacher used the Smart Board to access the Internet and a particular speech.

A Year 1 teacher in School 2 described a different way of thinking about the use of the Web when s/he found that accessing material on the Internet could provide valuable opportunities for reading mileage and differentiated activities related to this: “We have found some really good reading Internet sites, and they just think they are playing computer games, and they don’t realize what they are doing.”

Modelling and sharing learning. Teachers often reported using laptops and data projectors as tools to model practice in some way, including the teacher or other students modelling how to do something. For example, in a new-entrant class (kindergarten) in School 1, the teacher used the laptop and data projector to model sentence construction. A sentence written by a child formed the basis for the teacher’s input.

I said to J, can we use your “story” to all look at it together, and so we put J’s story up, and we read it and see what it says, then we think about what else we could add to it, say to make it a little more interesting…. I do try to use it as a way to show them what is expected….

Another teacher at School 1 described how Year 4 students modelled and shared their learning in mathematics. The teacher videotaped children who had gained a new concept or worked really well with a particular strategy, so that they could explain it clearly, as they gave an explanation. “The next day for maths, the group will watch the video, and then, hopefully, the children can see how we use language to explain what they are learning, what they are doing,” the teacher explained. The benefits are twofold: increasing student...
confidence and enabling those children who are struggling with a particular concept in mathematics to hear it again in “child-speak” while, at the same time, they see a peer physically doing a maths operation.

**Articulating learning.** Technology was helping students to articulate their learning in these schools in a number of ways. At the simplest level, technology can capture and support the reporting of learning, as described above. Another example is from an integrated studies unit in School 2, where Year 7 and 8 students produced posters or brochures on the computers about an environmental issue. However, the medium assumed greater significance because they were reporting in German, a language they were studying that term. The computer medium served as an ideal way to capture the information in visual form, a necessary support, given the students’ basic level of German. The pictures carried most of the message, supplemented by the core, basic German vocabulary that the students had learnt. With limited linguistic knowledge, they were still able to convey quite sophisticated ideas.

School 1 demonstrated potentially powerful ways to allow students to both articulate and consolidate learning. The Junior Oral Screening Test (at 5 years 1 month) had consistently shown children entering the school to have an average age, in terms of oral language, of 3 years and 3 months (a large number of children are English language learners). So a key goal in the junior school was to build basic vocabulary. The new-entrant children were working on positional vocabulary, as they were known to have difficulty with the words under, over, on top, in etc. These children had, the previous day, gone into the playground in pairs with a digital camera and taken photos of one another in various stances or positions (largely in, over, and under, but also upside down). The camera operator gave instructions about where his/her partner should be. They directed their own photo shoots of five pictures each. When they returned, the teacher connected the camera to his/her laptop and downloaded the images. The class quickly viewed them, and each selected his/her favorite. The next day, that photo was available for each child, and in pairs they talked to one another about it, practicing the positional vocabulary. Each had a turn sharing a sentence with the group. Finally, each child recorded the sentence, which was then linked to the photo on a PowerPoint so that the whole class could view it and have the positional vocabulary reinforced in a meaningful context. Each slide included the question “Where is…?” and the recorded response was played as if answering.

Also in the new-entrant and Year 1 classroom, the teachers used the digital camera and laptop to extend the practice of oral storytelling. The teacher reported that after the shared book reading, s/he used to get the children to retell the story orally. But now s/he used photographs of people and actions (they had a large props box in the classroom) to record the story. The children “take the pictures, like creating a story board, and put it through Photostory, and it speeds up and transition itself into a little movie.” The children then narrated
the movie. Oral language is stimulated as they work together and recall the vocabulary to retell. Also, the notion of sequence is developed.

**Experiencing the world outside.** Technology allows students to “see” the world. They can view the world through the likes of Google Earth. One teacher at School 1 reported “rehearsing” the route of a trip before the children took it so they would be cued as to what they would see on the way to their destination. These children were unfamiliar with the surrounding city, as they seldom left their own suburb or area. The teacher also mentioned a time when they were reading about the Golden Gate Bridge and it was “so easy” to find a picture of it online to show the students, to help with “lots of [necessary] prior knowledge stuff.” An aim, always in the foreground at this school, was to extend vocabulary, and students not only talked about what they were seeing but kept a class book of new words.

An example from School 2 of using technology to experience the world outside their own context was using e-mail to talk with a biologist in Antarctica as students worked on a research unit. They seemingly told her what they knew, and she commented on and added to their knowledge. The children took a printed copy of an e-mail from the biologist to share at home with their parents, furthering the reach of their learning. It was a focus or a talking point to enable them to discuss with adults what they had learnt. When we interviewed the students, one said, “She sent like a seven-page e-mail to us…. I’ve got the e-mail in my bag.” Clearly, the e-mail and the process had an impact on this student, as s/he was still carrying the e-mail around several weeks later.

Students in a School 3 classroom also experienced virtual shopping and living on a budget using online sites. The task required them to plan meals for the week, look up suitable recipes, buy ingredients, and stay within a budget—a cross-curricular undertaking.

**Recording experiences.** The use of digital cameras to record experiences was seen to promote learning in different ways in all three schools. In writing at School 2, for example, the use of visuals was a memory aid in terms of what actually happened, which helped students (in this case, Year 1 students) to re-visualize the events, placing them clearly within the context. The use of:

... real visuals … when the children see themselves in the photo … helps their writing, because whilst they’ve got their memories, if they can physically see the progression [of the Eagle helicopter landing] and the people that spoke to them, it's helping them to process what it is they're actually writing.

At School 1, we saw young students writing while a PowerPoint of their experience played on a data projector. In this instance, they had been to the park nearby and “played” in the leaves. The students then came back to class and wrote about the experience. The pictures of the actual experience enabled them to be more descriptive and authentic in their writing.
Facilitating interaction. Interacting by reading and commenting on someone else’s writing through a blog was seen in School 3. Blogs, however, also served a broader function of coordinating learning. A teacher showed us the blog site s/he had set up, where w/he posted tasks and suggested sites as resources. Students posted their responses to the tasks, and peers asked questions, “and then it all goes on … questions to questions and answers to answers; it’s more co-operative, more co-constructivist.” This teacher expressed the belief that blogging enhanced the exchange of ideas in class, “giving their opinions, interacting, thinking about what other bloggers are saying.” And, as the posts all come past the teacher, s/he has the ability to review and assess students’ ongoing work and perhaps use the content for an individual conference.

Interviews with students in School 3 reinforced the value of posting writing so that others can read it and give feedback. Although one confessed it was “a bit nerve wracking really knowing that people can read what you are writing, it’s also good to find out what they think, from another person’s perspective.”

There was a common belief in this school (and in the others) that the use of technology engages students. Tellingly, when asked what they might miss if they were to attend another school, students at School 3 talked of “getting to interact with other people and things.” The people were featured as well as the technology; in fact, the technology seemed to facilitate the interactions.

Enablers and Addressing Constraints
To realize the affordances of the technology available and for it to function as a solution to issues of practice, these schools had to address constraints on use. Infrastructural supports and those emanating from leadership and a school culture of professional learning are the dominant themes here. The nature of the resources for technology varied among the schools, but they notably shared a common strong commitment to providing teachers and students with what they require. In all instances, this necessitated additional funding, which was sourced in a variety of ways, including external grants and fundraising. School leadership at each of the schools recognized the importance of providing appropriate resources.

Common features across schools were access to the Internet, data projectors, and/or interactive whiteboards in classrooms as well as in common spaces, such as multimedia rooms. These allowed teachers to use their laptops as an interactive resource that extends the functionality of a “blackboard” considerably. Computer access for students varied across the schools from multimedia units to banks of computers in the classrooms and portable sets of laptops. Digital cameras were extensively used in two schools.

Within each school, the senior leadership was highly supportive of the teaching staff and was clearly proactive in ensuring that the school vision and goals were being met. How this was done and the nature of that leadership...
varied, but across all was the sense that the key leadership role was facilitating and supporting effective learning and teaching. However, it also involved providing instructional leadership. In School 3, for example, the principal was a visionary educator with strong, well-developed philosophies around learning and teaching. These had come from international research and other literature but were very personally driven within the school. The principal was seen as the source of high-level ideas that others then turned into practice. The senior leadership team was highly motivated and supportive of the principal’s theories of education, as were key members of the staff. One of the teachers affectionately described the principal as “the ‘mad genius’ at the core of what we do.” The extensive use of technology in the school aligned with the enacted vision of invitational learning.

All three schools had identifiable “teacher champions” who provided models of effective practice for other teachers. Their enthusiasm for the potential of ICT, their understanding of the relative capabilities of their colleagues, and their willingness to help others were key features of their leadership, which was both formal (School 1) and informal (Schools 2 and 3).

At School 2, a teacher had been specifically employed to lead the ICT integration in the school through modelling and sharing expertise. ICT was fully integrated into her/his own practice to an exceptional level. What was perhaps central to her/his success in motivating others was a low-key approach and willingness to support in a nonthreatening way through the modelling of practice. S/he talked of “taking away the barriers which teachers felt they had” in terms of using technologies and of trying to set expectations that teachers could meet. Moreover, s/he considered each teacher’s needs and current level in relation to technology use and designed support accordingly. In this way, s/he was personalizing the learning of the teachers to ensure both authenticity and appropriateness. S/he worked on the belief that you make the small things easy for teachers and they will be inclined to try more. S/he provided the kind of just-in-time support that the literature often says is needed.

At School 3, several champions were highly motivated and skilled in innovative uses of ICT. They modelled successful practice in their classrooms and were willing to share their knowledge and experience with others. The senior management team fully supported and encouraged them to take risks and try things.

Each school had a strong professional learning culture that was evidenced in teacher interactions with one another and in the language they used when discussing their professional practice. We saw it in the conversations we had with them as well as in the fact they were willing to speak openly about their practice and welcomed our presence. Teaching here “is more like being in a creative industry for me because I don’t feel stifled,” offered a teacher in School 3. The principal also talked of the place of creativity in the school culture, describing something akin to a
contagion effect. What he described was how “people did interesting and creative things…. At this school there is no mandating…. It evolves.” A teacher echoed this, explaining that it was “like I got onto blogs and wikis really early and I passed that on to S; now S has led podcasting.” When we quizzed one of the teachers about the potentially overwhelming nature of some of the ideas that the principal (described as the “creative director” by one interviewee) might espouse, s/he responded that it was “OK to freak out because there are half of us who are able to help others.” This school had a formal system of buddy coaches “that helps to cater for people coming in at different levels.” The notion of collegial professional support was also strong in the other schools, if not as formalized.

Discussion and Implications

All three schools had some strong commonalities, despite the differences in approach and focus. First, each of the schools had a clearly articulated vision for learning. Second, in each the use of technology was natural and unforced; they employed a wide range of ICT, media, and pedagogies, where appropriate, to meet student needs and enrich their learning experiences. Technology was also ubiquitous in terms of planning and professional work.

It is worth noting that the study described here is a limited snapshot of learning and teaching in three schools in New Zealand. As such, the learning and teaching this study describes cannot be viewed as representative of New Zealand primary schools, although we tried to ensure that it was a valid picture of the practice of the teachers and schools concerned. Rather, the research provides a picture of what is possible when teachers and students are engaged in learning activities mediated by ICT. Further, similar studies are required to understand more fully how teachers use ICT to solve problems of practice across a range of environments.

The learning culture in all three schools was also very apparent. Each of the teachers was willing to talk to us and share their classrooms in an open and transparent manner. They readily engaged in professional conversations and talked of the support and expertise of their colleagues. Whether informal or formal, peer modelling and coaching was common. We also noticed how these schools saw the chance to be involved in the evaluation and the present in-depth study as a learning opportunity.

The role of the formal leadership in these schools cannot be understated. Each of the principals was very different in personality and leadership style. Yet there were similarities in the way they supported the staff and facilitated the implementation of the agreed-upon vision. That there were clearly articulated and implemented learning and teaching goals and strategies is a reflection of the coherence within and across the schools. In addition to the principal, there was at least one teacher champion in each school. It’s important to note that they were very aware of the capacity of their colleagues, the need for small steps, and the need for both collegial support and gentle challenge.
The extent and nature of the infrastructure in each school was very different. Each had obviously been contextualized to fit the school culture and climate and the needs of the students. Whereas the infrastructure at School 3 was extensive, the other two reflected what can be achieved with a carefully constructed plan and pragmatic decision making. It should be noted, however, that all three schools highlighted the cost of their infrastructure and the fact that ways of finding extra money had been necessary.

The laptops were an integral part of this infrastructure. In every example we saw of learning and teaching, the laptops had had some part to play. Our previous forms of data collection in the larger evaluation had not brought home this point. The laptops were so integrated that their use was no longer explicitly acknowledged, so, in previous focus-group discussions, teachers had not articulated that which, for them, had moved to a subconscious level. Laptops had become, to a large extent, an invisible part of these teachers’ toolboxes.

Whereas two of these schools were in high or reasonably high socio-economic areas, the third was not. It is important to note this and to realise what can be achieved at any school where there is sufficient will and desire. A focus on meeting the needs of students and providing them with a variety of opportunities and ways to learn is perhaps the most important ingredient of all.

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