

Infrastructure for what? What infrastructure?

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1. Introduction

The use of new technologies in schooling is dependent upon a robust infrastructure. But what sorts of infrastructure are required and for what purposes? If we accept that the core business of schools is teaching and learning, and we accept that teaching and learning now includes the integration of new technologies, then we must also accept that the infrastructure of schools and school systems has to emerge from what we want to happen in classrooms with our students, irrespective of whether those classrooms are physical, or in an online environment or are a mixture of both.

New technologies are providing us with a conceptual lens through which to broadly re-think the emerging characteristics of schooling. School transformation is being promoted as necessary if schools are to remain purposeful in the 21st century. The integration of new technologies into classrooms is seen as fundamental to transformed schools.

It is argued here, that the infrastructure required to include new technologies into school education requires complex inter-relationships to be developed and maintained between schools' human, organisational and physical infrastructures. Here 'infrastructure' refers to the underlying frameworks or systems that enable schools to function. Often the word 'infrastructure' is interpreted only as the physical buildings and equipment within a school. Here, the term 'infrastructure' is interpreted more broadly to encompass the stock of services, facilities, processes and people required to enable a school to undertake its' work of educating students.

Combining infrastructures requires a new metaphorical architecture for schools: an architecture that enables the integration and coordination of the respective infrastructures. The discussion in this paper addresses some key issues schools and school systems face in developing such an integrated architecture. Some premises, possible issues and potential solutions are canvassed concerning the development of inter-related infrastructures that enable the integration of new technologies into students' learning: hence the title - Infrastructure for what? What infrastructure?

2. Premises

This paper is based upon the following four premises about the nature of new technologies in school education.

2.1: Technologies are socially constructed

All technologies, including the infrastructure established to support their deployment, are socially constructed; they are designed and built by people who have their own views about what is 'good' or preferable in certain circumstances. There is no ultimate truth however, about how technologies ought to be constructed or used. It is argued here though, that the nature of the control and use of technologies is a question of what human, organisational and physical models are adopted; the nature of decision making exercised; and who has access to the skills, facilities, and knowledge essential to design, implement and employ the technologies.

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2.2: The language of 'new technologies' is still under construction

There is no universally-shared understanding about the language used to describe 'new technologies'. The introduction into schools of different technologies sees these technologies labelled with several different names. Collectively, the computing infrastructure provisions of schools usually includes the hardware, software, Internet services, networking and connectivity requirements necessary for the teaching, learning and administration of schools. These different devices and processes however, tend to be all lumped together and referred to variously as 'information and communication technologies' (ICT), 'learning technologies' or 'new technologies'. These terms are often used interchangeably and without any clarity about to which particular device or functionality is being referred.

A range of technologies including computers linked to the Internet through telecommunications services including broadband and through satellites; wireless technologies; personal digital assistants (PDAs); other handheld devices such as notebooks and laptops; and interactive whiteboards are all examples of technologies that are used in schools. These devices each use different sorts of software. Both synchronous and asynchronous software is used to support online learning. Synchronous software enables learning to occur with participants taking part at the same time, and asynchronous software enables learning to occur (to use the proprietary catch phrase) 'anytime and anywhere' (Microsoft 2000).

Administration of schools including activities such as record-keeping (eg of students' attendance and finance and asset management); information provision (eg through online daily bulletins); online content (eg through the use of publicly and privately developed materials accessible over the Internet); and borrowing books (eg through the library) are supported through online networks and databases.

For the purposes of this paper, I will use the phrase 'new technologies' so that the language is consistent with the online conference topic, and by this I mean networked computers linked to the Internet to support learning, teaching and the administration of schools. In this paper, where other hardware or software is being intended, reference will be made specifically to that piece of technology by name.

2.3: The infrastructure of schools must support students, educators and administrators to plan, construct, assess, report and reflect on learning

New technologies are promoted as having the capacity to 'transform' teaching and learning, and by default, schools. Australian school education policy statements promote this view (cf Department of Education and Training (Victoria) 2003; State of Queensland 2000; New South Wales Department of Education and Training 2005). If new technologies are to play a role in changing or 'morphing' schools into places that foster transformative teaching and learning, structural changes to both the physical and social constructions of schools are required (cf Wise 2005). Here, the term 'structural' is used broadly to refer to those organisational aspects of schools which support teaching and learning, and not only include the physical attributes of schools but also include the human infrastructure and the organisational philosophy, policies, rules and traditions that define what people understand as fundamental to the functioning of an organisation, whether that is an individual school or a school system. In other words the human, organisational and physical computing infrastructure of schools must support students, educators and administrators to plan, construct, assess, report and reflect on learning.

2.4: School leadership is necessary to bring about successful change

Transforming schools implies change. It has long been recognised that school leadership is fundamental to bring about successful change (cf Hopkins & Levin, 2000; Naughton 2000). Leaders both provide the 'spine' or the 'glue' and legitimate the essential philosophical, moral, organisational and educational processes of change. Leaders can stand back from the day-to-day activities and dilemmas that occur in schools to take an overview of what is happening. Leaders therefore have a central role to play in the introduction and integration of new technologies into the infrastructure of schools. For example, the nature of the technologies used in schools and how they are deployed and utilised have social consequences, and so school leaders have a responsibility to enable their school communities to understand the nature and consequences of the diffusion of particular technologies for their students' education. Determining those technologies that may (or may not) support school transformation should be a part of such processes.

3. Possible issues

To be able to determine 'what infrastructure' requires us to answer the question 'infrastructure for what'? Placing students at the heart of the work of schools sees much promised by policy makers of the potential of using new technologies. The benefits for students and teachers of using new technologies are often promoted. The articulated benefits include:

- Fostering collaborative learning;
- Increasing the ability of teachers to personalise learning;
- Enabling the ability of schools to track students over time and place;
- Enabling the faster provision of learning options;
- Supporting learning to occur 'anytime, anywhere' (Microsoft 2000);
- Enabling online content to be customised and reused;
- Providing rapid data to teachers about their students;
- Enabling the presentation of abstract concepts in more concrete ways;
- Fostering networked links between students and teachers within and across schools and between schools and home;
- Increasing critical thinking and multi-literacies; and
- Enabling simulation and modeling of learning environments (cf Spring 2004).

These benefits are seen as contributing to the transformative capacities of introducing new technologies into school education (cf Australian Capital Territory (ACT) Government 2004; State of Victoria 2002). Professor Brian Caldwell defines 'transformation' as

... change that is significant, systemic and sustained, resulting in high levels of achievement for all students in all settings. It applies in challenging circumstances, and contributes to the well-being of the individual and the nation (Caldwell 2004: 5).

Conceptualising school transformation in this way presents significant challenges to all those working in school education and places weighty responsibilities on school leaders in facilitating the change processes. This paper asserts that to achieve the aim of 'transformation', the deployment of new technologies in school education requires complex inter-relationships to be conceptualised, developed and maintained between the human, the organisational and the physical computing infrastructures of schools. Here some of the possible issues underpinning this assertion are outlined before moving into a discussion about some potential solutions.

3.1: Human infrastructure

The human infrastructure of schools refers to the staff in schools and school systems: that is teachers, school leaders, school support officers, administrators and policy makers. The human infrastructure of schools is supported with professional learning and operates within the constructs of the appropriate human resources policies and practices of the school and/or school system. Fine teaching and effective leadership are important factors in enabling schools to ensure quality student learning.

Transforming schools to utilise new technologies raises issues such as what experiences, skills and abilities are required of teachers, school leaders, school support officers, administrators and policy makers so that the desired changes can be planned, introduced and maintained? What is the role of school leaders in enabling systematic changes to take place? What are the barriers to the use of new technologies by educators? What sorts of professional learning do the respective members of the teaching profession require to enable their informed use of new technologies? These are but a few of the human infrastructure puzzles facing educators envisaging how school transformation that incorporates new technologies can be achieved and sustained.

3.2: Organisational infrastructure

Here, an organisation is considered a human structure; a group of people who work together. The organisational infrastructure of schools includes the leadership and management that enables common visions, shared directions and joint purposes to be developed and pursued. Organisationally, within schools and schooling systems the use of new technologies is framed in terms of their importance for the organisation to become a 'learning organisation' where 'continuous improvement' is required to achieve such an organisation. Education Queensland's '2010' strategic plan illustrates the inter-relationships seen between new technologies and organisational development stating that

quality schools will divest themselves of traditional industrial age and bureaucratic restraints to reinvent as dynamic 'learning organisations' in 'learning communities' (The State of Queensland 2000: 10).

To achieve these outcomes, Queensland schools are becoming dynamic learning organisations in networked learning communities, flexible, innovative and responsive, focused on student learning and that work closely with parents and business; ... all underpinned by excellence in the use and application of information technology (The State of Queensland 2000: 13).

The introduction of new technologies into the various education sectors' workplaces is one of the reasons why the concepts of continuous improvement within learning organisations are advocated.

The phrases 'learning organisation' and 'continuous improvement' have been adopted from business, human resource management, strategic management and enterprise theories (cf Senge 1990; Mintzberg 1994). Motivation for adopting the concept of a learning organisation has been linked with the impact of various technologies on work and the advent of the 'knowledge' or 'information society' (cf Field and Ford 1995; Lepani 1995). Tapscott (1996) asserts that 'to be successful in a knowledge economy, firms need to overcome their organizational disabilities and create learning organizations [where] organizational learning occurs within teams' (Tapscott 1996: 202). Ellyard (1999) asserts that 'it is recognised that both individuals and

organisations must learn continuously in order to adapt to changing circumstances and to develop new skills and capabilities to thrive in a rapidly changing world' (Ellyard 1999: 64). These challenges, raised by Tapscott and Ellyard also pertain to schools.

Linked to the concept of 'continuous improvement' is the perceived necessity for standards against which improvements can be measured. In such an environment, learning and skill development therefore, become critical to organisational productivity, growth and innovation. Determining the sorts of knowledge, skills and experiences required to enable educators to contribute to the organisational changes sought that include new technologies however, is an emerging challenge for school communities.

Schools around Australia are grappling with the best way to organise themselves in order to accommodate the use of new technologies. Most schools in Australia, while to varying degrees are self-managing, nonetheless sit within a systemic policy structure. Research into the organisational structures for information technology (IT) deployment (cf Frissen & Loader 1997) assert that centralised structures are more cost efficient than are individual local arrangements. There is the ability for organisations such as schools to band together to leverage strategic advantage with private providers of computing and telecommunication products and services. Little work has been undertaken in Australia however, on how self-managing schools can best marry their self-managing status with centralised approaches to new technologies.

3.3: Physical computing infrastructure

The physical infrastructure for Australian school education traditionally, has been intimately linked with the tradition of the provision of 'free, compulsory and secular' schooling to all of Australia's children. Attendance at 'school' has been equated with physically attending classes located in school buildings. The respective state Education Acts, since their inception, have made the attendance at buildings called 'schools' compulsory between the ages of 5 or 6 to 15 or 16 (depending on the jurisdiction). Since the beginning of the 20th century, where physical access by students to these buildings has not been possible, there has been the provision of distance education; first in print and now, online.

As new technologies are becoming a part of school education, the physical infrastructure of school education now not only refers to the buildings and classrooms in a physical sense, but in addition requires computers, and access to robust, reliable and cheap telecommunications and electricity supplies. Local and wide area networks are required if we want to link learners together within schools, between schools, and between schools and home. In unprecedented ways then, individual schools and the school education sector is working closely with the computing and telecommunications sectors to provide this infrastructure. Fundamental to using computers and the Internet in collaborative, networked ways, is the provision of bandwidth.

Bandwidth is a national infrastructure requirement necessary to enable transformative 21st century schooling. Currently in Australia however, there are no agreed policy guidelines for determining bandwidth requirements for particular outcomes, nor for schools and school systems to either analyse their current usage or to predict future requirements (Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) 2003a). Yet appreciating the technical and the educational premises underpinning the requirements for bandwidth; having the skills to participate in partnerships with the relevant service providers; and realising the implications of these partnerships on schools, are all important issues for school leaders to

understand; but this is new work for many school leaders.

Discussions about the processes for transforming schools tends to include the benefits of gathering and using recent, evidentiary data to inform practice (cf Hargreaves 2004; The Allen Consulting Group Pty Ltd 2004). The collection of quantitative data about different aspects of school life such as student and staff attendance, students' progress including their achievements against standardised tests, or participation in extra-curricula activities however, assumes the existence of databases set up with distributed mechanisms for data entry and data access, and underpinned with the assumption that people within schools are suitably skilled to be able to accurately enter and interpret such data in order to take informed actions. Some schools in Australia are at this point, but many are not.

Principals and other school leaders who hold a responsibility for overseeing new school building developments or redevelopments are considering issues such as where to put power points so that computers can be plugged in and utilised. In doing so, they are asking what sort of assumptions about learning does the placement of power points imply? What sorts of classrooms are required to enable and accommodate different learning styles? Addressing these questions however, and those outlined above, requires bringing the human, organisational and physical computing infrastructures of schools together conceptually into a 'new architecture' of schools. This is a complex task but one to which we will now turn in order to briefly examine some of the complexities currently facing schools.

3.4: A 'new architecture': interplays between the human, organisational and physical computing infrastructures

It has been argued (cf Hargreaves 2004) that one of the promises of integrating new technologies into the work of schools is to enable schools to be 'learner-focussed'. To use new technologies to foster learner-focussed approaches to teaching and learning and to transform schools, it has been asserted here, requires coordinated interplays between the human, organisational and physical computing infrastructures. Two different views on how a school provides and uses computing equipment is outlined here to illustrate some of the different interplays that can occur. Both these scenarios have been simplified in order to illustrate the points: it is acknowledged that the real life of schools is more complex than the examples used here.

Scenario one

In the first scenario the provision of a physical computing infrastructure is the primary focus. Decisions about what new technologies are required in the school are controlled by the staff member with IT as their major responsibility. Issues such as price, the amount of hard drive space and memory are central to the decision-making processes. Human and organisational infrastructure issues are considered secondary or tertiary in priority. The provision of the computing equipment is valued intrinsically and in this scenario, the computing infrastructure is seen as symbolic of a modern education. The nature of the equipment chosen influences the curriculum and pedagogical requirements of the learning environment and as such influences the sorts of skills technical support officers require. It also influences the sorts of technical and pedagogical skills teachers and students require, and therefore, it influences the sorts of professional learning teachers require in order to integrate the equipment provided in meaningful ways into classroom activities. The human, organisational and physical computing infrastructures are all interacting, with the computing infrastructure acting as the driver.

Scenario two

In the second scenario, students' learning is placed at the centre of decision-making processes. Firstly, the sorts of teaching and learning to be undertaken, is envisaged. The planning stages include determining what new technologies are required, and where and when these technologies can make a difference to the quality of the teaching and learning. The sorts of equipment, the physical layout of the classroom and the organisational and human infrastructures required within the school to enable learning environments to be constructed that seamlessly incorporate new technologies emerge as a consequence of determining the desired learning outcomes. The curriculum and pedagogical requirements necessary for high quality student learning outcomes influence the nature of the equipment chosen and as such influence the sorts of professional learning teachers require. The physical, human and organisational infrastructures of the school then, are constructed around the sorts of teaching and learning to be undertaken.

Both these scenarios show the complexity of coordinating the interplays between the different infrastructures that operate within schools. The way new technologies are deployed influences the nature of the school reform processes and depending upon the approach taken, can affect what is learnt and how it is learned, both by educators and students. Implementing an integrated 'architecture' that brings together the human, organisational and physical computing infrastructures required in schools, in ways that meet learners' requirements and sees the respective infrastructures form an integrated and coordinated whole however, represents a challenge for schools and school systems, not previously faced. But it requires asking: 'What infrastructure? Infrastructure for what?'

4. Potential solutions

Identifying and implementing an integrated 'architecture' that brings together the human, organisational and physical computing infrastructures of schools is required if schools are to be transformed in ways that include new technologies. Some principals upon which solutions as to how this can be achieved are proposed here as a starting point. The solutions are based upon the four premises outlined earlier:

1. Technologies are socially constructed;
2. The language of 'new technologies' is still under construction;
3. The infrastructure of schools must support students, educators and administrators to plan, construct, assess, report and reflect on learning; and
4. School leadership is necessary to bring about successful change.

Given that schools have to determine what is best for their particular context, some principles are proposed here that could be used to guide actions. These few principles are not exhaustive, but are intended to enable discussion around them, which in turn, is likely to then generate further principles and ideas for action.

4.1: Place student learning at the centre of decision-making

What students learn and how they learn are fundamental purposes of schooling. The 'Adelaide Declaration on National Goals for Schooling in the 21st Century' (MCEETYA 1999) provides an outline of the agreed goals for school education in Australia. Students' learning is at the core of this statement and so too, student learning must be at the core of decisions made about the respective infrastructures of schools. The availability of new technologies provides ways in which to plan and provide teaching and learning not previously available, but the choices of those new technologies and how they are to be used should be based upon how they will improve student learning outcomes: how the new technologies will improve the quality of the teaching and the quality of the learning as a result of their deployment and use.

4.2: Develop a vision and a plan

Determining a new architecture (ie the integration of the human, organisational and physical computing infrastructures) for a school requires imagining what the future school is to 'look like' and to plan to achieve that vision. Planning that accommodates the integration of new technologies involves identifying the interdependencies between the different infrastructures; identifying the points where different decisions will generate different dependencies and outcomes; and integrating the respective strategies. Scenario planning (cf Schwartz 1996) may assist in visioning and planning processes.

4.3: Choose the environment right for the job: start with the learning not the technology

Determine the different styles of teaching and learning and the nature of the student outcomes being fostered, and identify the sorts of new technologies most beneficial to achieve the desired outcomes. Determine what sorts of information is required to be recorded; identify the information that is beneficial to the daily work of teachers; and determine the digital flows to enable that information to be placed at teachers' fingertips. Then determine the sorts of technologies that will compliment and/or assist in these activities. The MCEETYA ICT in Schools Taskforce has developed a 'Learning Architecture Framework' (MCEETYA 2003b) which has been developed to assist schools plan a computing infrastructure that enables sharing of information between different IT systems.

4.4: Identify the leaders

Both formal and non-formal leaders with the knowledge, skills and abilities are required to support the development, implementation and sustainability of the new architecture of schools. Identify the key people to provide leadership in school reforms and build them into a team. Legitimate and value the many perspectives available from different leaders. Enabling many perspectives to solve issues as they arise is effective since under many eyeballs all problems are small (Raymond 1999).

4.5: Link personal and organisational learning

School reform generally is a result of deliberate modification in structures by those inside the school (cf Bosco 2003). Throughout the 1990's authors in Australia and overseas (cf Fullan 1991; Hawley & Valli 1999; Oliver 1994; Senge 1990) have asserted that there is reciprocity between personal and organisational learning. Personal professional learning that enables educators to incorporate new technologies into their work means that those facilitating the professional learning must meaningfully include new technologies as a part of that learning, not as an adjunct or addition: the professional learning has to be a recognised part of educators' work, and be contextually appropriate, integrated and coordinated. Establishing and maintaining the human and organisational infrastructures supported through professional learning programs that enable meaningful use of the computing infrastructure will enable schools to transform.

4.6: Remember: physical embodiments reflect philosophical beliefs

It has always been the case, that the embodiments of school education, most obvious in the physical design of schools, reflect the philosophical beliefs informing the construction of those buildings. Hargreaves (2004) refers to 19th and 20th century schools having been modelled on the asylum, prison and factory. So too, decisions about the new technologies used in schools represent deeper philosophical views about the political, social and instrumental implications of those technologies and of schools. Decisions about the new architecture of 21st century schools must provide a democratic basis upon which to base students' learning.

5. Conclusion

The fundamental purpose of a school is to provide all students with a high quality education that will enable them to confidently, critically and creatively take their place in their world beyond school. New technologies pervade our world and there is no reason to expect this situation to change. School transformation to bring schooling into the 21st century, it has been argued by authors such as Hargreaves (2004) and Caldwell (2004) is now urgent. It has been argued in this paper that school transformation that incorporates new technologies in meaningful ways requires complex relationships to be developed and maintained between the human, the organisational and the physical computing infrastructures. Some premises and possible issues concerning such a proposal have been canvassed and some principles for fostering discussion about potential solutions have been proposed: so let the conversations continue around the questions – ‘infrastructure for what? What infrastructure?’

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