EDGES, EXPONENTIALS & EDUCATION: EXTENDING THE UNIVERSITY, DOING SCHOOL DIFFERENTLY

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Abstract
The changed and changing circumstances of a world in which the performance of key technologies is improving at an exponential rate poses unique challenges to schooling systems that had their origins in the industrial revolution. This paper argues that there is a warrant for thinking about doing school differently. It traces the origins and details the key notions of a small project in Australia in which schools operate as sites of serious knowledge production.

Key words
exponential change, knowledge producing schools, children as knowledge workers, patterns of human behaviour, computers in schools

Resumen

El cambio y las circunstancias cambiantes de un mundo en el que el rendimiento de las tecnologías clave mejora a un ritmo exponencial plantean desafíos únicos para los sistemas escolares que tuvieron su origen en la revolución industrial. Este trabajo sostiene que existe una forma de pensar en hacer escuela de manera diferente. Se rastrean los orígenes y los detalles de las nociones clave de un pequeño proyecto en Australia en el cuál las escuelas se convierten en lugares de producción del conocimiento serio.

Palabras clave

Cambio exponencial, escuelas que producen conocimiento, niños como productores del conocimiento, patrones del comportamiento humano, ordenadores en las escuelas.

During the writing of this paper, our nine year old twins were given a science “project” to complete at home and at school. It consisted of them making a poster depicting the things they have been learning during the term. The topics included the Moon, the seasons, planets etc. They have explicit instructions *not* to look anything up on the Internet because otherwise the teachers won’t be able to tell if their parents have helped them or not. Leaving aside the importance of school-family partnerships in the education of the young, we were reminded again of the limited and limiting way in which the digital resources of the world are domesticated in some school settings. While it is tempting to dwell on this task, we simply note the prevalence of *busy* work in much of the work young people do at school and the difficulties teachers have in encouraging and supporting students to do actual research. In a way, this small moment from a particular class in a local school captures many of the ideas we want to develop in this paper.

We live in a time that by any measure is substantially different from earlier periods not just in terms of the various technologies that are to hand but also in terms of the new patterns of behaviour that these technologies support. The increasing pervasiveness of the digital sphere continues to produce patterns of human responses that are largely unanticipated and, in some cases, prove to be significant for existing social institutions and practices. Rather than draw on theories and sensibilities which derive from earlier periods we have selected a number of patterns which we argue are worthy of consideration in any attempt to think about schooling in such a period of human history. Attending to patterns frees us from the conventional approaches to thinking about change or reform of schooling. The approach we have adopted in this paper is to take schooling as a set of practices that have been more or less relocated in a complex and inter-related set of patterns which, when taken together provide a context for schooling which is strange, difficult to anticipate and potentially at odds with the conventional views of what schools are for.

To say that the world has changed as a consequence of the deployment of computing and communication technologies is a considerable understatement. There should be no need to rehearse observations about the growth of original digital data and the ease with which capital is moved about the planet, with recent dire consequences (for instance, see Taleb, 2004, 2007). What is perhaps most remarkable is the little impact that these technologies have had on the practices and familiar patterns of schooling. While this is not the focus of this paper, we take a little space to briefly trace the history of computer use in schools to provide a sense of one of the drivers for the work this paper describes.

In the beginning

The commercial availability of what were then termed microcomputers in the late 1970s marked the beginnings of more widespread use of these technologies in schools. The particular technologies and policies that informed classroom use varied somewhat from country to country. When they are looked at in hindsight, there may be differences in when particular pieces of hardware and software became vogue but the broader patterns of use, the issues teachers raised and the problems they encountered bear strong resemblances from country to country. Clearly here, we are talking about the over-developed countries of the world that could afford to acquire computers and their associated technologies.

Back when all of this began, and of course today, the computer was and remains a powerful signifier of a positive computer-based future: future jobs, future opportunities and the future shaping of human activity on the planet. Leaving aside the technological determinism that underpins such associations (Bigum, 1998), the symbolic role of these technologies has been an important component of the logic and the rhetoric of policy and promotional documents. There are basically two responses to any new computing-related technology (Bigum & Rowan, 2008) that is promoted for educational purposes: domesticate it (Bigum, 2002b; Salomon, 2002; Tyack & Cuban, 1995) or ban it. This is not intended to be a criticism of schools or teachers. We are of the view that the circumstances in which schools find themselves vis-à-vis computers are most difficult if not impossible. The logic that determines the importance of computing and communication technologies in schools supports blaming teachers or looking to new graduates to solve what is described from the outside as a simple problem.

The problem is far from simple as we have argued previously (Bigum & Rowan, 2008). The use of computers in classrooms has been framed largely in terms of using CCTs to support the teaching and learning of a pre-existing curriculum, pre-existing in the sense that the knowledge and understandings deemed to be important in schools have changed little since the introduction of computers. Curriculum is inevitably contested but it is the case that there is a very large teaching workforce whose skills, professional identity and knowledge is tightly tied to keeping things more or less as they always have been. The difficulty of even modest reform in schools is well documented across many countries and over many decades. In an era when there is such easy access to information it is ironic that what young people learn in formal settings is so tightly controlled.

From finding useful things for computers to do to rethinking schooling

Computers were the beginning point of the thinking that led to what is described in this paper. From the earliest days, the seeds for developing a critical sensibility about computer use in schools were planted. The enthusiasm of the hobbyist teachers who took computers into classrooms was built on by vendors who saw schools as key sites to promote a more widespread take up of these technologies in the home. Computers were positioned as improving things, the employment opportunities of the young, learning in general, access to information and routine administrative tasks in the school. What always occurs when a technology is inserted into an set of existing practices is that things change. The disruption to schools took the form of a reallocation of time in the timetable to classes concerned with computer use and the associated allocation of resources to acquire these technologies (Bigum et al., 1987). What was less apparent at the time was that schools had entered into a cycle driven by the release of new hardware and software on a diminishing cycle time. Coupled with the appearance of new product were the original arguments and justifications for using computers in the classroom. The claims have now been used for almost thirty years and despite a small number of notable critiques (for example, Cuban, 2001; Stoll, 1999) the same rationales are still being used.

Recycling the justifications for using computers and related technologies in schools is an important part of maintaining a coherent educational aura around them. Paradoxically, the failure of an earlier technology to live up to its promises is translated as a good reason to purchase the next generation in which all the problems of the previous generation are fixed. This was not an unreasonable approach given the instability and complexity of early versions of system and application software. Now, upgrades are a requirement to stay in the game. The effort to stay with old software and hardware becomes prohibitively expensive. So schools continue to loop through generation after generation of hardware and software, largely accepting of the inevitability of it all. Here is a model for the cycle that appears to operate.

1 A new computing or related technology appears on the market.

2 Arguments are made concerning the *improvements* that the technology will make to existing teaching/learning practices. This is an important and necessary step in terms of recruiting support. The technology has to be positioned so it appears as a solution to a particular problem. So the initial story has to be constructed around current practices. It would make little sense to claim an outcome that was unfamiliar and impossible to foresee the unexpected outcomes. It's only justification can be in terms of what is already known, but importantly it has to be in terms of a current problem of some kind or other. This is what Sproull and Kiesler call first level effects--

"the planned efficiency gains or productivity gains that justify an investment in new technology" (Sproull & Kiesler, 1991, p. 4).

3 The justification for acquisition is successful and the new technology is put in place.[1]

4 Then one of two things happen. In the process of adoption, interesting things happen that bear little relationship to what was imagined, what Sproull and Kiesler call second level effects, "..people pay attention to different things, have contact with different people, and depend on one another differently" (Sproull & Kiesler, 1991, p. 4). There is little point or interest in evaluating the original claims.

Alternatively, step 1, a new technology or upgrade appears and new efforts go into making a case for its acquisition.

The cycle repeats itself with the regularity of the seasons. We are not suggesting that participation in this loop need necessarily be construed as evidence of mindless consumption. Though the logic of consumption figures prominently in the patterns of computer use in schools.

It was in these circumstances that universities began to offer courses to support teachers interested in making use of these technologies in schools. For the most part, these courses tended to follow a promotional line with an emphasis on "how" with little attention to the "what" and the "why" of computer use in the classroom. In Argyris and Schön's (1974) terms, the interest was and continues to be on single loop learning, that is the task is to work on and improve the way computers are used to support teaching and learning. No questions are asked of the overarching rationales for this work. Double loop learning is not entered into.

In the 1980's, Chris was teaching courses to support teacher engagement with these technologies at Deakin University. The teachers had signed on to do a course in computing and education via distance education as it was then called. The courses ended up being much more concerned with teacher professional development as they puzzled about the use they made of particular computing resources they had to hand. In these courses we encouraged teachers to challenge many of the then and still now taken for granted assumptions about these technologies and education. Walking teachers through double loop learning in that climate was tricky but rewarding. Teachers acknowledged the uncritical nature of what was going on in schools but argued that universities should help them develop educationally defensible

[1] Implementation is never a simple matter and is always a matter of compromise and negotiation (Latour, 1996).

practices. It was in these discussions that countering the then current *consumption of information* logic that characterised the use of computing and related technologies in schools began. The notion of schools as sites of information *production* became an interesting proposition. The idea was further explored in conversations with teachers. It looked to be well suited to the middle years of secondary school. When this proposition was canvassed with Primary teachers, their reaction was one of amazement. They firmly pointed out that Primary schools do a large amount of data gathering but never did anything with the data they collected. This was the beginnings of the notion of the knowledge producing school (KPS) and which was subsequently developed in Primary schools in Queensland and Victoria (Bigum, 2002a, 2002c, 2003, 2004; Bigum & Rowan, 2009; Rowan & Bigum, 2004b).

Beginnings

To give a sense of how it came together, we recount an event at a Primary School in the mid 1990s. Chris had received an invitation from the Principal to attend a professional development day. The school had been given some funding for computers and part of their brief was to support other schools in the region. The session was held in a small teaching space in which there was a circular arrangement of i-Macs on tables. There were fifteen to twenty Principals in attendance. The Principal of the host school welcomed everyone and introduced the school's computer support person. He spoke very briefly and then introduced the people who would give the professional development program. In walked twelve or so Year Four students. They ran the entire session. They taught the Principals about movie making (Claymation animation), and sound and image editing. The students were excellent teachers. They were patient and supportive as they worked with Principals sitting on the floor in their suits arguing about animation sequences in the movies they were making. In relation to the role of the school as a hub for professional development for computing in schools, the Principal was invited to give a presentation to a Principals' conference. Her immediate reaction was to visit a Year Five class and give them the brief for the task. The students shot and edited the film for the presentation, burned it to a CD and gave the presentation at the conference.

While having students carry out some tasks in schools is commonplace, it is less common to see them do work that is typically the domain of teachers and adults. This Principal had stumbled onto an important idea some years earlier when teaching in an outback school. Like all Principals she was juggling many things on a day when there was a barbeque to be organised. In desperation she gave the task to a group of boys from a Year Five class. They completed the task perfectly. They did the ordering, organised the amounts, the cooking and the managing of visitors to the school for the event. For her, it was

a powerful lesson of what young people can do when given the responsibility to carry out tasks that matter.

There are many stories that can be told about this work about having young people do the work that normally is the province of teachers and Principals[2]. Bringing together this notion with the idea of schools as sites of serious knowledge production proved to be significant. What followed in this and a small number of schools was a broad range of projects in which schools drew on community expertise in order to do something that the local community valued. From producing a documentary of a local meat industry which was subsequently distributed at an international beef conference and adopted by the local Council as part of an orientation package for new residents to the community, to building a museum in a school that captures the century long history of the school supported with iPod recordings of oral histories, to persuading a road traffic authority to alter the traffic designation of the highway near the school using a speed radar gun, to producing touch screen video to support local tourism in an old gold mining town, the KPS agenda has produced a rich and externally validated set of experiences.

The important feature of KPS work is that when students come to see that what they are doing will have use by other adults or be publicly available, their commitment and engagement in the work is orders of magnitude greater than what one normally finds in a classroom. Commenting on the KPS agenda, Colin Lankshear and Michele Knobel (2006, p. 255) suggest that this pedagogy provides:

> opportunities to explore what is involved in pursuing learning outcomes that meet real-world standards of proficiency and expertise, in the company of experts who can help learners and teachers keep theory and concepts, ideas and arguments, data and analysis closely related to generating viable and serviceable values. The KPS approach is dialectical. It brings elements of the conventional and new, that are often in tension within established educational set-ups and routines into a productive and risky 'conversation'. It works with these tensions to resolve and transcend them in ways that are fruitful for learning. The result is a different pedagogy that is neither wholly 'conventional' nor wholly 'new': yet it bears visible traces of both tendencies.'

While there has been a number of curriculum reforms which emphasize but rarely enact authentic tasks for students, KPS pedagogy is premised on the product being published or made public in one form or other.

[2] Some are recounted in the references of this paper.

Perhaps the single greatest difficulty in this kind of work is persuading adults that young people can, with appropriate access to mature insider forms of knowledge, produce cutting edge, valuable knowledge products of various kinds. As the Principal in the school where it all began is fond of reporting when adults see the outcomes of her students' work: "wow, did kids do that?"

KPS work points to a new and different kinds of relationships between schools and their communities. Here in the notion of community we include universities and other potential sources of expertise. Rather than seeing community as a place where school operates to meet the needs of parents and caregivers, schools can be repositioned as resources for the community, places where, with appropriate support, valuable work can be done that benefits and supports local interests and needs.

To us, the KPS agenda is one of what is a growing number of small experiments at the edges of schooling that might be labeled as doing school differently. Experiments like this matter when we consider the challenges that this generation of young people will face in this century.

Coping with a world increasingly driven by exponential change

I n an era when debates about schools and schooling for this century are now commonplace, it seems to us that simply recycling the practices, and mindsets of the past does little to address the educational needs of the young. This is particularly so when we consider the trajectories of driver technologies that appear likely to be influential in shaping this century and beyond.

One of the key characteristics of the technologies which underpin the behaviours of people who make use of contemporary computing and communication technologies is that the price/performance of the component technologies continues to improve at an exponential rate[3]. While the exponential function is well known, it is arguably, poorly understood. As Bartlett puts it[4], "The greatest shortcoming of the human race is our inability to understand the exponential function."

As Kevin Kelly (2008b) argues:

> All extropic systems — economy, nature and technology — are governed by self-accelerating feedback cycles. Like compounding interest, or virtuous circles, they are powered by increasing returns.

[3] Triplett (2003, p. 29) estimates that the cost of computing power is now one thousandth of one percent of what it cost fifty years ago.

[4] http://en.wikipedia.org/wiki/Albert_Bartlett

> Success breeds success. There is a long tail of incremental build up and then as they keep doubling every cycle, they explode out of invisibility into significance. Extropic systems can also collapse in the same self-accelerating way, one subtraction triggering many other subtractions, so in a vicious cycle the whole system implodes. Our view of the future is warped and blinded by these exponential curves.

A similar point is made by Ray Kurzweil (2001) in his exposition of his law of accelerating returns. He posits that:

> An analysis of the history of technology shows that technological change is exponential, contrary to the common-sense "intuitive linear" view. So we won't experience 100 years of progress in the 21st century -- it will be more like 20,000 years of progress (at today's rate).

Importantly, this is not about predicting how these developments will play out but simply that the key driver technologies for this century: computing and communications, biotechnologies and nanotechnologies are all subject to similar doubling cycles, cycles which continue to get shorter (Bostrom, 2006). What this adds up to is a world that is much less certain than it ever was, a world in which different patterns of human activity have begun to alter and shape the way the world works.

While some of these patterns are, as Kelly (2008a) has argued, impossible in theory but proved to be possible in practice[5], they are, for us, markers of shifts that will challenge many social institutions and disrupt many familiar and well established patterns of human behaviour over time (Weston, 1997). Despite the proliferation of predictions for schooling, it remains unclear how these shifts will play out in education. What we can say however is that the patterns, some long standing, some emergent when taken together, provide a warrant for thinking about doing school differently.

It is in this context that we find the arguments put by most major educational bureaucracies that more of the same is what we need to prepare the young for the challenges that will flow from these developments to be completely disingenuous.

Accessing expertise

As we have detailed above, access to mature insider forms of practice, not “pretend” versions (Rowan & Bigum, 2004a) of these practices enacted by well intentioned teachers in schools is at the heart of any shift that needs to occur. This is not to suggest that teachers are now somehow obsolete but that new and important roles for teachers are in prospect. In KPS work getting

[5] Wikipedia is a good example.

access to expertise is something that young people cannot always manage by themselves. There are many projects when they did but equally, there are important instances of teachers facilitating access to such expertise. In one instance at a secondary school, teachers sourced expertise over the Internet to support their twelve year old students hand making of telescopes. This involved grinding lenses to mm specifications. Part of this work saw these students organise and run astronomy nights for local primary school students and interested adults.

While the Internet has long supported a very large number of groups who share their expertise about almost every imaginable area of human interest, recently Chris Anderson (2010) argued that the ease with which video can now be used to share expertise was driving interesting patterns of innovation.

It is interesting to note that, to date, apart from our roles with schools in supporting research and promotion of these ideas in the academic literature, that university input into many KPS projects has been minimal. This has arisen because the adult networks to which young people have good access tend to be that of their parents and parents of their friends.

Universities have had a limited "research" relationship with schools. More often than not, the agenda is driven by the university and schools are positioned as unpaid helpers to a project that is conceived, developed and implemented from inside a university. The argument we put here is that the KPS agenda points to a new and different kind of school-university relationship, one in which the local interests and needs of the community as expressed through a school sets the agenda.

This represents a new and different mode of information gathering than has been evident till now. Most will be familiar with the three contemporary forms of information gathering that are employed by various research agencies to obtain data. Briefly, there are the click collectors (Google is the exemplar here); the survey beggars (low paid people who use the telephone to elicit information from people); and government agencies, who operate through formal data collection methods such as tax collection, census taking and other legislated means of obtaining data. The characteristic of these data gatherings is that they are carried out at a distance, for purposes that meet the interests of people who are remote from the local site and who normally aggregate and average data from a large number of smaller, local sites to meet their analytical purposes[6].

[6] There is a story told of a small island community in Victoria which, each census night would meet to fill in their census forms and collude so that when the data was mapped, their island stood as high or low on a number of the census measures.

We posit that in an increasingly globalised world that good, detailed knowledge about a local community matters. As Paul Saffo (1994) put it: “In a world of hyper-abundant content, point of view will become the scarcest of resources”. Point of view, expertise, place to stand and make sense of things is what will matter. For a community, being an expert in itself, knowing the detailed and significant facts about what is going on rather than relying on remote agencies to tell it what is going on will matter more and more. Seeing a school as a place that is capable, with appropriate support, of conducting useful, local, specific research that is valued by the local community is important. We see the kind of work that would produce such data as not simply a replacement for busy work in many schools, though that would be no bad thing, but as a key feature (learning how to do research), for any future citizen.

To put this in some perspective, Clay Shirky (2010) coined the term “cognitive surplus” to describe the free time, partly masked by TV until recently, that people in over-developed countries have available to them. Shirky describes examples of how this surplus time has been aggregated to accomplish collaborative projects like Wikipedia and Open Source software and a host of less well known but civically significant projects. In 2008, he estimated that the human effort that had gone into Wikipedia was about 98 million hours (Shirky, 2008). While this seems like a lot of time, if one compares it to say, for example, the time that a child spends in school in a year[7], one Wikipedia is roughly the equivalent of one year of school time for 220 schools with 500 students. This is not to suggest that school children are capable of building a Wikipedia nor that they don’t do useful things while at school but that thinking about school as a resource for local communities is both plausible and practicable.

The knowledge working young

We conclude by underlining the importance of taking the talents, skills and knowledge of young people seriously. It may seem odd to describe children, particularly those who attend primary schools as knowledge workers but, as many recent reports clearly show (Ito et al., 2008; Kaiser Family Foundation, 1999), the young now make extensive use of online games, social networking sites and video sharing sites to name the most prominent. While these patterns of behaviour are important and the subject of considerable research, we point to an underlying ability/capacity in the young to carry out tasks that, till very recently, were thought to be beyond them[8]. Here, we are

[7] In Australia.

[8] We are well aware of the discourse around the notion of the young being native to things digital (Tunbridge, 1995), having grown up in a world in which various digital media were commonplace.

describing what occurs outside school. Outside of school, it is not unusual to come across the achievements of the young in the arts, in sport, even in culinary activity[9]. While it is pleasing to see the acknowledgement of skills, knowledge and expertise in the very young, their collective success is seen largely in terms of their being exceptional. We want to argue that this group of publicly acknowledged young people is the tip of a very large iceberg of talent that is largely ignored in schools.

The notion of young people as a largely untapped resource is one of a number of patterns we have drawn attention to in this paper. Taken together, we believe they provide a warrant for rethinking schooling or simply, "doing school" differently. We do not want to suggest that the approach we have described in this paper is the only way forward but that there is a clear warrant for a rethink of schooling, the relationship between schools and their communities and the role of universities in providing the young with access to appropriate expertise. We think Kelly's assessment about developments like Wikipedia apply to the thinking we have tried to outline in this paper: impossible in theory but possible in practice.

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[9] The performance of eight and nine year olds on national television in the cooking competition, Junior Master Chef, showcases levels of sophistication and skill that are impressive by any measure.

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