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Issues of ICT, School Reform and Learning-Centred School Design

Schools need to become more tightly coupled, intentional learning organisations focused on the core business of schools – teaching and learning – within which ICT is an important and significant element.

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Executive summary

Around the globe systemic attempts at educational reform and restructuring all too frequently have failed, especially when driven by a desire to effect widescale change through the implementation of information and communications technology (ICT). Characteristically, seldom is the technology ubiquitous and deeply embedded in the integrated functioning of the school – from curriculum delivery to the effective financial management of the school; from intra and inter-school communication to administration of student data.

This scenario is equally apparent in the UK where, despite the investment in ICT, and although a number of examples of innovative and effective school-based initiatives are evident, nationally there has been a relatively ineffective, systemic translation of the broad, visionary policy goals of the Labour government into comprehensive school-based reform and improvement of teaching and learning environments. There seem to be a number of reasons for this:

- Issues of inconsistent opportunities for ICT connectivity for all schools.
- Issues of lack of equity of access for all students and teachers to ICT.
- An overemphasis on issues of equity and access instead of teaching and learning.
- Significant shortage of qualified teachers, especially in the south-east of the country.
- Inconsistent outcomes for National Opportunities Funding (NOF).
- Issues concerning some local education authorities (LEA) and their lack of coherent strategic initiatives to provide appropriate direction and suitable infrastructures for implementation of ICT.
- The tension between a culture of autonomous, self-managing schools which empowers headteachers with the responsibility for change and innovation, and the mandated national reform agenda.
- The implementation of government policy initiatives which are dependent on individual heads and their staffs and whose success rests upon the leadership qualities and vision of the headteacher and the culture and climate that he/she creates in order to foster and encourage change.

Yet, ICT is simply one of many reform drivers, and only one of the many expectations and demands that have been foisted upon schools. Over the last twenty years, with the decline in the other social agencies in the community – Church, neighbourhood and family – schools have been expected to take on larger and more comprehensive burdens in a more holistic approach to education that embraces everything from social to spiritual to pastoral to moral to academic dimensions.

In the face of all these competing demands, and given the consistent and predictable failure of attempts to reform and restructure schools, especially on the back of ICT, there is the need for an alternative approach in which schools are intentionally designed as learning-centred institutions. The precepts underpinning the design approach celebrate the importance of individual schools' unique cultures and contexts, yet at the same time provides a highly articulated, tightly-coupled approach that sets teaching and learning at the core. Predicated at a systemic level, it provides a common philosophy and set of guiding precepts, yet allows for regional individuality.

The learning-centred school involves the close connection and articulation of:

- outcomes driven, differentiated curriculum and teaching materials integrated with informed teaching practice
- teachers working in teams
- technology embedded in all aspects of school activity
- physical space configured to permit diversity of pedagogical strategy and activity
- clearly articulated position descriptions for all staff
- administrators as instructional leaders
- systematic and continuing professional development of teachers

This suggestion is not a panacea. It will not solve issues such as teacher shortages, nor will it provide immediate resolution of inconsistent equity of access or connectivity. What it may provide, however, is a much more strategic approach to achieve the laudable goals of the Government in raising the quality of educational provision. The role of ICT in transforming education must consequently be seen in its context: simply one of the constituent elements of effective school design. It should not be the driver of change, but one aspect of an approach to education that provides enhanced opportunities to serve its core processes: teaching and learning.

Introduction

Around the globe one of the strongest drivers for educational reform comes from the demand for schools to access and incorporate ICT as a means of transforming teaching and learning. Yet, the missing link in many ICT planning decisions lies in a clear definition of what is going to be done with it beyond a broad notion that it is important and desirable. Often too the implementation of ICT is externally mandated by government policy and education authority edict. As a result, the technology is frequently never fully utilised to support and enhance teaching and learning and thus improve learning outcomes. At the heart of this is the fact that technology is simply grafted on to the existing programme and against the existing school culture and infrastructure. Additionally, issues of school-wide access to the technologies and unfettered internet connectivity limit the opportunities for many schools to fully embrace the promises that are offered. Consequently, technology often either exists as a tangential activity occurring in discrete computer labs, or as an ancillary activity in some classes. Seldom is the technology ubiquitous and deeply embedded in the integrated functioning of the school – from curriculum delivery to the effective financial management of the school; from intra and inter-school communication to administration of student data.

In order for schools to address the next steps in ICT, they must first retrace a few, especially in the light of the calls for more accountability, greater efficiency and the demands for clear demonstrations of 'value-addedness' in individuated learning environments. Given the nature of many schools, this suggests a rethinking of school design: how education is delivered; how classrooms are designed; how teaching and learning is constructed; how educational technologies are deployed and employed.

Drawing from research, experience and example in innovative schools in the United States, Australia and Thailand, this paper reviews the context of the global drivers for ICT and the broad thrust of the issues confronting its effective implementation and use. Against this background, the contemporary situation will be explored in the UK where, since 1997, the Labour Government in its commitment to reform the quality of public education and improve schools has invested heavily in ICT.

In addressing both the global and the UK experience, a brief overview of an approach to learning-centred school design is discussed. Central to this methodology is the notion that schools need to become more tightly coupled, intentional learning organisations focused on the core business of schools – teaching and learning – within which ICT is an important and significant element.

Drivers for ICT

There is no doubt that schools carry with them a fear – fuelled by the media, ICT multi-nationals and parents – that if they do not keep up with the traffic on the infobahn, then they will be failing in their duties as educational institutions. And, there is some truth in this. Undoubtedly, if schools are to effectively educate young people to take their place in the 21st century, then they must provide an education that incorporates ICT. Furthermore, they must provide a critical ICT literacy that trains students in how to effectively determine the appropriate technology to use and when (or when not) to use it. Globally, mandated imperatives enshrine the centrality of ICT in schools, in curriculum and in pedagogy. For example, the Western Australia's Curriculum Council has determined that "areas identified for special attention are the use of technology as a tool to enhance learning and provide access to information, and the development of skills of collaborative learning" (Curriculum Council, 1998). The Thai national information technology policy, *Social Equity and Prosperity: Thailand IT policy into the 21st century*, is predicated on the view that: "How well an individual, an organisation and an entire society can harness, access, share and make use of available information will ultimately decide their ability to generate economic growth and enhance the quality of life for all" (Department of Science and Technology, 1995). And in the UK, not only in 1997 was there the promise in *Connecting the Learning Society* that, "by 2002, all schools will be connected to the superhighway, free of charge; half a million teachers will be trained; and our children will be leaving school IT-literate, having been able to exploit the best that technology can offer", but the Prime Minister, Tony Blair, declared in his preface to the document that:

> Technology has revolutionised the way we work and is now set to transform education. Children cannot be effective in tomorrow's world if they are trained in yesterday's skills. Nor should teachers be denied the tools that other professionals take for granted. (Department for Education and Skills, 1997)

However, although schools continue to invest huge amounts of money, they receive little demonstrable return in improved student outcomes. Furthermore, successive technological leaps have meant that school computers are often seen to be obsolete as soon as they are installed. This has led to a widespread reaction against the further implementation of ICT. This backlash, coalescing around characters like Clifford Stoll, author of *Silicon Snake Oil* (1995), has led to a sometimes polemical, but often justified, questioning of the educational value of ICT and the ways in which it is currently utilised in education. This is reflected in Dertouzos' trenchant observation that:

> The lack of a major breakthrough in a mere two decades shouldn't be construed as a license to perpetuate tired teaching methods and avoid innovation. And yet "the old way" is preferable to a blind adoption of information technology in schools, on an irresponsibly widespread scale, based on the assumption that if the technology is deployed en masse, surely a thousand educational flowers will bloom. (Dertouzos, 1997)

At the same time, it can be seen that successive waves of reform have led to little real change in pedagogy and practice. Schools are fundamentally little different from those of a hundred years ago.

Against this backdrop, there are of course the pundits that would see the death of schools as we currently see them. In any number of speculative and highly rhetorical works, futurists such as L.J. Perlman advocate “hyperlearning: the new technology and the end of learning” (1995). He is not alone; from the feminist perspective in Australia, Dale Spender argues for a similar decline in the place and position of schools (Spender, 1994). These critics argue that the increasing use of ICT will enable students to spend more and more time at home as telescholars, digitally commuting to school by modem, meanwhile having access to the best international pedagogues and the best and most authoritative information by way of the world wide web. This reconfiguration of the purpose of schools as simple conduits for the delivery of information is in itself of concern, for it takes a narrow view of their role and function. Arguably, schools are imbued with much more than a narrow academic focus and encompass learning in a range of social, moral, ethical, civic and indeed spiritual domains more effectively acquired in an environment of community than in an electronic cloister of individually accessed information.

One of the other forces shaping the agenda for reform, of course, comes from demands for accountability of the educational process. Without going deeply into the area of quality assurance and the current climate of standards, benchmarks and accountability, it is apparent that in all areas of public and private sector endeavour, there is the demand for organisations to demonstrate value-addedness. This is evident in education around the globe, and governments and government authorities are developing a range of strategies to evaluate schools’ successes in determining whether value has been added to a student’s attainment through their educational experience. The Office of Standards in Education (OFSTED) in the UK, and the inspectorial institutions such as the Office of Review in the Department of Education in Victoria, Australia, are examples of these approaches.

If there is difficulty in addressing how much value is added by an individual school through its curriculum, it is equally, if not more, difficult to determine the impact and effect of ICT on enhancing student learning outcomes. Given the expense of ICT and the powerful drivers to adopt it, it is clear that this is one area alone that needs careful scrutiny.

The realities are that few students use computers often enough in meaningful ways to expect achievement effects, despite significant reductions in student/computer ratios and significant increases in expenditure. As a result, very few schools have technology embedded systemically in their curriculum – that is, technology permeating all the activities of the school: from learning activities through to the administration through to the communications within the school. Hence, despite all the investment and all the expense, little demonstrated value is being added.

If the reluctance of a generation of teachers unfamiliar with the uses of ICT is factored in, then the inertia is compounded further. In Australia, for example, the average age of teachers is around 45 years old. Many of these teachers have grown in the profession empowered by the idea that they are the repositories of canonical wisdom, that they control the knowledge base in the classroom. If it is suggested that this is no longer the case, if on the basis of the introduction of ICT the position and power of the teacher is fundamentally revised, then it is not surprising that there is reluctance. If also, teachers

are placed in a vulnerable position where the key teaching and learning strategy is something that they are novices in – that is, the practical use of ICT – and many of their students experts, it makes it even more difficult.

Although it may be seen that some teachers themselves acknowledge and value the importance of ICT in enhancing student learning, there is little evidence of comprehensive and wide-scale reform. The combination of rhetoric, expense, unfamiliarity and fear of disempowerment all contribute to an absence of real change in the classroom.

ICT and the UK

ICT policy and implementation

The experience in the UK seems to reflect these same trends. Since 1997, the Labour Government has been committed to improving the quality of public education in the UK. Indeed, Blair has unequivocally declared that it is his government's first priority (Department for Education and Skills, 1997). A significant part of this change agenda has been in the investment in ICT to effect reform and improvement in teaching and learning. The vision for ICT, set out in *Connecting the Learning Society*, advocated the establishment of the National Grid for Learning whose focus:

> …will be a way of finding and using online learning and teaching materials. It will help users to find their way around the wealth of content available over the internet. It will be a resource for everyone in our schools. For example, a teacher will be able to get advice on effective ways of teaching children how to read. Pupils will be able to revise for their GCSEs or explore the museums of the world for their project work. Standards, literacy, numeracy, subject knowledge – all will be enhanced by the Grid and the support it will give to our programme for school improvement. (Department for Education and Skills, 1997)

This vision has been rearticulated and reconfirmed consistently over the last five years. Since its inception some £1.6 billion has been invested in realising it (McMullan, 2002).

However, a number of headteachers argue that despite this significant sum, and despite the many examples of innovative and effective school-based initiatives exploring and exploiting the power of ICT, there has been a relatively ineffective, systemic national translation of the broad policy goals into comprehensive school-based reform and improvement of teaching and learning environments. As Baines – a former head of a comprehensive school in the East Midlands – suggests:

> There are some examples of good practice in the use of ICT in teaching and a growing literature of case studies offering ideas. It is difficult though for someone who visits as many schools as I do to avoid the conclusion that we are still in the foothills. (Baines, 2002)

Mike Wood, headteacher of The Cornwallis School, Kent, also points out that, "there are pockets of excellence, pockets of experimentation" but limited developments in a comprehensive sense on the national agenda. A position endorsed by Neil McLean, Director of Evidence and Practice at British Educational and Communications Technology Agency (Becta), who suggests that: "What we have are islands of excellence, a few areas where schools are using ICT well" (Millar, 2002).

OFSTED's report on the effect of government initiatives in ICT on schools suggests too that there is a long way to go (OFSTED, 2002). The use of ICT is improving, but "good practice remains uncommon"; levels of LEA support "vary greatly, but are often too low to meet schools' needs"; training for teachers has increased their use of computers, "but

only rarely to the pedagogic expertise to help them make the most effective use of ICT in their lessons" (Millar, 2002).

This is a view implicitly confirmed by Tom McMullan in a review of ICT in education in the UK, *Wired to Learn: What's holding up the school of the future?* (McMullan, 2002). McMullan identifies a number of weaknesses in the Government's approach to the provision of school access to ICT, inconsistent and narrowband connectivity for many schools to the internet, and developmental impediments for both students and teachers by problematic individual access to ICT. McMullan concludes his review by stating that the most important recommendation would be for governmental policy to put "the needs of the individual learner and not the needs of the provider at the heart of our educational system" (McMullan, 2002). Evidently, the dream of *Connecting the Learning Society* is a long way short of the reality.

But where are the perceived points of breakdown and why are the visionary initiatives not achieving more comprehensive adoption? Despite the investment, and although a number of examples of innovative and effective school-based initiatives are evident, nationally there has been a relatively ineffective, systemic translation of the broad policy goals into comprehensive school-based reform and improvement of teaching and learning environments. There seem to be a number of reasons for this:

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As a result, change has not been systemic or systematic; further, it is clear that change is not seen to arise out of a design-focused approach to coherent reform of teaching and learning, but out of particular and individual school-based circumstance.

Access to ICT and teaching and learning

Bain (1995; 1996; 2001) argues consistently that one of the most important issues to tackle in establishing effective uses of ICT in supporting teaching and learning is ubiquity of access. That is, all learners and teachers must have equity of access to ensure that there is the possibility of universal use. In this way, educational programmes can be developed in a comprehensive manner and technology can be employed to its potential.

Great Barrier Reef project

In the non-government sector in Australia, it is possible to achieve this. At St Michael's Grammar School in Melbourne, for example, all students from Year 9 upwards must have a laptop computer that accords with school-described specifications – continuing enrolment at the school is naturally dependent upon students having a laptop, just as they are expected to have appropriate textbooks, uniform and so on. All computers are imaged by the school with specific software requirements and configured to the school network. All teachers are provided with laptops and professional development in the expectation that they actively engage with the development of online learning and flexible use of ICT in its ability to individuate learning. Hence, St Michael's has an ICT-rich learning environment in which there are a multitude of opportunities for pushing the potential for technology in enhancing teaching and learning.

An example of this potential can be seen in the school's Great Barrier Reef project. Underpinned by the principles of 'situated learning', the project aims to challenge the notion of the traditional classroom by taking students away from the school to where their learning had a particular and specific contextual core (Alexiades, Gipson and Morey-Nase, 2001). In this case, the Year 10 students' primary focus lay in a Victorian Certificate of Education Unit 1 Biology course; a semester length (20 week) course normally delivered to Year 11 which centres on the comparative study of marine and land-based ecosystems. Now in its fourth year, the project installs 25 Year 10 students in the James Cook University Marine Research Station on Orpheus Island, one of the Greater Palm Island group on the Great Barrier Reef in far north Queensland and 2,500 kms from school in Melbourne.

In addition to their intensive Biology studies, students are also exposed to the cultural and historical background of far north Queensland through a broad-based humanities programme designed by the School of Indigenous Studies and the Faculty of Social Science at James Cook University.

In order for students to be adequately prepared for their time away on Orpheus Island, they also undertake a vigorous and rigorous training programme, which includes snorkelling and skindiving, food preparation, menu planning and cooking, Level 2 First Aid Certificate and Bronze Medallion Lifesaving Certificate. The students also work together to develop a Code of Conduct for the time that they are away and to which they all agreed.

The project is as successful as it is because of the manner in which ICT is employed and deployed. To begin with, all students had access to their own personal laptops. As the expectation was that they all would keep up to date with their other studies at St Michael's while they were on the Great Barrier Reef, and given that much of the

curriculum at the school is delivered online, technological solutions were found to ensure ongoing connectivity to the school's local area network via the internet. In the first year – 2000 – a satellite telephone link to the school's virtual private network was established and a local area network was set up on the island so that students could work offline, sharing and transferring data between one another. This required particular infrastructure, including server, router and hub, connected to the satellite telephone.

In 2001, this was made somewhat easier by the establishment of a 128k microwave link direct to James Cook University on the mainland. So far, this has satisfied the technological requirements of the students who have been on the project in 2001 and 2002. In turn, this has enabled staff at St Michael's to more effectively deliver lessons and learning tasks via the school's intranet and to communicate with students by email. Students, while on the project, complete tasks offline, then upload their modules to the school's intranet on a daily basis for teachers to mark, comment on and return. Students have also communicated with the Biology classes at school and school assemblies via videoconferencing, and consistently sent back pictures.

There is no doubt that St Michael's Grammar School, through the Barrier Reef project, has shown that the classroom can be deconstructed and the teaching and learning environment can be changed dramatically. Furthermore, it is the embedded use of ICT which aids in effectively supporting the situated learning context while also ensuring that other areas of the curriculum are not neglected during the students time away from school. The power of ICT in this context cannot be denied, but its efficacy is undeniably linked to the students having their personal laptop computers, ubiquitous access to other appropriate technologies, considerable infrastructure and technical support and the facility of consistent and uninterrupted access to the internet.

Unfortunately, public sector schools – in Australia and in the UK – are unable to mandate the same compulsion for students to purchase computer hardware, nor do they necessarily yet have access to the same level of ICT infrastructure and resourcing. As a result, it is significantly more difficult to create the kinds of technology-rich environments that lead to significant reforms in teaching and learning. Despite the UK's considerable investment in ICT developments, there are clearly gaps between the vision and the reality. A report in the *Guardian* reflects this:

> Cut back to the present day, to Landywood primary school in south Staffordshire. Alan Stockley, the headteacher, would love to be at the helm of a school of the future. Instead his 505 pupils have to make do with 26 computers of recent vintage. To come anywhere near meeting the government's target for primary schools of one computer for every 11 pupils by the end of next year, Landywood needs about 46 machines; even at his most optimistic, Stockley reckons that he'll be at least six PCs short. And that's not allowing for the replacement of older models. (Millar, 2002)

Nonetheless, Ken Walsh, the headteacher of King Edward VII School in the UK, argues that ICT must be 'embedded' in schools if they are to realise its potential. But the notion of 'embedded' suggests an approach that requires a much more comprehensive use of technology than simple access. Bain argues that the most effective use of technology in education comes when it is invisible in the day-to-day running of the school, when it is no

longer seen as unique or special, but simply the way in which things are done. He argues that this occurs when ICT is fully integrated into curriculum outcomes and lesson activities and where teachers are actively engaged in the construction of learning materials using the technology – and this means from the use of authoring software through to email through to word-processing. In addition, ICT is also used to manage seamlessly the intelligent functions of the school – from student management/ information systems through to financial administration. Finally, ICT is at the core of the teaching and learning process and students use and build curriculum-referenced software and "create new knowledge in doing so" (Bain, 1996).

Tridhos School, Thailand

An example of the kind of comprehensive and fully-integrated approach to school design and educational reform is reflected in a visionary project in northern Thailand that unfortunately was significantly compromised by the Asian economic crisis in 1997. Although the flow-on financial issues from the crisis led to its demise, Tridhos School Village in Chiang Mai was supported at the highest level by government figures, politicians and the Ministry of Education – the Chairman of the Board of Governors was the former Prime Minister, General Prem Tinasulanonda – and was a bold attempt to drive educational reform, initially in Thailand and then more broadly across South East Asia, through the construction of a lighthouse school which incorporated best practice pedagogies and where the uses of ICT were ubiquitously embedded in all aspects of the learning organisation. This naturally led to a number of challenges and difficulties, not least of which was the issue of moving teachers away from traditional Thai paradigms of teaching towards more Western, student-centred, experiential approaches to education.

There are many lessons to be drawn from this project. There is no doubt that commitment to a comprehensive ICT plan directly woven into the fabric of the curriculum and the teaching and learning model provided a highly articulated vehicle for educational innovation and a reforming vision in the school. The tightly-coupled connections made between technology use, curriculum and pedagogy at an early stage of the school development also meant that the design of classrooms and technology infrastructure could reflect the demands of the teaching and learning programme. However, as experience in the project attests, the move from design to implementation provided many complex frustrations and engendered many costly problems because it was not conducted with integrity to the original plan and as a consequence sight of the original vision was lost.

What was also evident at Tridhos was that the poor leadership and limited levels of expertise in the ICT support team contributed to the disappointing use of technology within the programme. The failure to invest in quality staff skilled and familiar with ICT simply led to poor utilisation of the technologies, limited return of investment, and ultimately a significant dilution of the original educational vision. [For a comprehensive account of the project see Gipson's *Tridhos School Village: Lessons from importing a western model of school design into Thailand* (2001).

At Tridhos, the issue that fundamentally compromised the project was not the commitment to the design, but its implementation. The ideal was clearly understood: fully

integrated ICT in support and delivery of the teaching and learning and employed in all the intelligent functions of the school was at the heart of a reforming vision of education.

It seems that schools in the UK could be seen to be distant from this ideal – though it is attainable. Brewster Academy, the school of which Bain is associate headmaster, exemplifies what can be achieved by this kind of embedded use of ICT. Yet, at King Edward VII School the use of ICT in the management of student information, for example, is almost archaic. Using a number of databases, and subject to the prescription of their LEA, the school is not able to manage as effectively as they would like their knowledge of student information and achievement nor such things as their timetable and so on. Walsh reports that this is an issue for a number of schools whose various administrative needs are not met by one system and who have problems with compatibility between applications (Walsh, 2002).

Despite this, schools in the UK such as King Edward VII, Sawtry Community College and The Cornwallis School, have sought creative and innovative ways to assure, as far as possible, a greater level of access amongst their student populations. One major suite of strategies has been the sourcing of alternative funding to supplement government grants: the use of the e-Learning Foundation, accessing corporate sponsorship and developing strategic relationships with providers. Other schools, such as Thomas Tallis School and St Martin's-in-the-Fields High School, have developed schemes whereby parents pay an additional levy of between £2 and £5 a week in order to access portable technologies (Hoare, 2002) – though this is also causing some concern amongst the governors of St Martin's-in-the-Fields (Johnston, 2002).

King Edward VII, Sawtry Community College and The Cornwallis School all have sought to access the almost universal home use of ICT in their populations. Sawtry's online learning community is driven by the philosophy that they will never be able to ensure universal access for all students within the school, but that students will almost certainly have access to the internet outside school. Consequently, they ensure that their curriculum goes online and much of their learning programme is accessible through the internet. The Cornwallis School similarly recognises that its broader community has a significant level of independent access; "between 80 and 90 per cent" claims headteacher, Mike Wood, "have home computers and access to the internet". Much of this potential capacity in ICT is underutilised in supporting the work in schools. This reflection is not new; Professor Stephen Heppell of Ultralab recommended this strategy as a means of resolving access issues as long ago as 1996.

Despite this potential capacity for ICT access through home and community sources, Wood claims that there is also a common set of ideas about the use of ICT which is predicated on the view that until there are appropriate levels of access within schools, then "you can't make progress". He argues that this whole notion needs to be turned on its head, for it has led to inertia in some schools:

> A lot of heads of English schools are stuck with the idea that when the authorities get the infrastructure right, when all the hardware is right, then they'll do something about ICT and the children. It's scary. You've got to get the kids working; you've got to get the teachers working. And then out of that experimentation come all sorts of exciting ideas which will lead us forward.

However, as Wood implicitly suggests, even if all the home computers were to be employed outside school hours for supportive, educational use, there is a continuing fundamental issue which inhibits the realisation of ICT's real potential in transforming teaching and learning: that is, ubiquitous access within schools.

Access remains a critical problem in most schools and is a prerequisite to embedding ICT within the curriculum. As long as ratios of five plus students to each computer prevail in schools, access will remain as a critical barrier. While access to ICT is clearly not sufficient to ensure meaningful use by students and teachers, it is an obvious and necessary prerequisite. Access goes hand in hand with curriculum integration. Weave technology into the very core of school operation and a number of the barriers to curriculum integration are reduced, if not removed entirely. For example, can a teacher assign a homework activity which involves spread-sheeting some data from a science experiment, knowing that not all of the students have access to the hardware and software necessary to do so? Is it possible for a teacher to develop a computer-based presentation at home, knowing that the facilities do not exist within a classroom to deliver the presentation to students on a subsequent occasion? Can a network be used to post homework, with the knowledge that not all students can access the information and later download a copy from another location? Most important, are all of these activities routine? Can Monday's class activity involving technology be followed up at the next class session, or only on Friday, or next week when the class has its next booking in the computer laboratory?

Hence, for technology to realise its power and potential, it must be rigorously embedded in a clear and intentional programme and be ubiquitously accessible across the school.

Allied with ubiquitous access to technology is also the issue of ubiquitous connectivity. McMullan (2002) argues that establishing effective and appropriate levels of external connectivity for all schools is one of the major hurdles to overcome in order to maximise opportunities for learning. Clearly, as described above, some schools have sourced alternative means of providing internet connectivity to enhance learning. But, as McMullan argues:

> Significant weakness remains in the provision of connectivity to schools. Although some 99 per cent of schools are connected to the internet, the vast majority of such connections are narrowband, with far too many computers per school connected via relatively slow links.

As a result of this, the June 2001 OECD report on broadband access for schools ranked the UK as 22nd out of 30 countries (McMullan, 2002). There is certainly a distance to travel in ensuring ideal connectivity for all schools.

Teacher shortages and change implementation

Around the globe there is an undeniable shortage of qualified teachers. In Australia, for example, Preston's report for the Australian Deans of Education, *Supply and Demand to 2005*, indicates that in 2002 there is a significant shortfall of teachers at both primary (16%) and secondary (12%) level. By 2005, should current shortages continue, only 69

per cent of primary positions and 59 per cent of secondary positions will be filled (Preston, 2002).

It is evident too that in China, New Zealand, the United States and many other countries, governments are increasingly concerned about the declining supply of teachers and the increasing demand. Not surprisingly, this has led to wealthier countries actively recruiting teachers from elsewhere. The UK, for example, has sought to attract teachers from Commonwealth countries whose curricula and educational systems are similar – Jamaica for example. While this has enabled the UK to attempt to replenish its declining stock of teachers, it has done little for Jamaica, which now has inadequate staffing for its own schools as more and more teachers are lured away by higher salaries offered by British educational authorities (Baker, 2002). Yet even for the UK this not the solution that it might be, for overseas recruitment is no guarantee of quality. The case for closure of Norton school in Hertfordshire, which recruited a large number of overseas teachers on short-term contracts, was predicated on the poor quality of education provided by some of its teachers (Woodward, 2002).

Similarly, in order to address the shortage in the UK, greater numbers of unqualified teachers have been hired. A recently released report, *Teachers in Service and Teacher Vacancies January 2002* (Department for Education and Skills, 2002a), indicates that there has been a significant rise in the numbers of staff without qualified teacher status (QTS): from 2,300 in 1997 to 7,600 in 2002. Furthermore, there are now 3,200 “on routes to QTS”, that is undergoing further training, against 400 in the same position five years ago. Quite clearly, this reflects the demand to ensure that there is at the very least appropriate levels of adult supervision in schools, but it does little to ensure innovation and change in curriculum and pedagogy.

It appears that in the south-east of the UK, the endemic shortfall in teacher numbers is compounded by the higher cost of living. The impact of this is exemplified by Mike Wood of The Cornwallis School who cites a cluster of 12 secondary schools in Kent which has only one qualified Physics teacher. Examples like this lead critics such as Phil Willis, the Liberal Democrat Shadow Education Secretary, to suggest:

> Schools are being forced into making the unfair decision between whether they should have qualified teachers and huge class sizes or unqualified teachers and smaller classes. It is appalling that essential subjects like ICT are being taught by unqualified teachers, particularly in contemporary Britain where the government claims it aspires to an online and computer literate society (Curtis, 2002, July 4).

As Wood claims, too, it is not a case now of looking for innovative young educators skilled in the uses and applications of ICT in enhancing learning:

> In the English situation there were some of us who were saying three years ago that maybe that’s exactly what we were looking to do. Then came the appalling realisation that no longer are we looking for teachers who have particular ICT skills, but we are simply looking for bodies to put in front of children and that is very, very frightening.

Hence, one of the biggest impediments in attempting to reform schools through the use of innovative practice and ICT lies in the significant teacher shortage. An absence of qualified teachers, particularly those in highly specialist areas, means that there are markedly fewer opportunities for any kind of innovative practice or specific ICT-led initiatives.

This shortfall in qualified teachers, coupled with a workforce that is also ageing (Curtis, 2002, July 4), or simply leaving the profession (30% of recruits leave within three years (Smithers, 2002) has led to a highly volatile teaching force characterised by a high turnover. Wood claims that in some schools in Kent this is as high as 30 per cent – translating potentially into a complete replacement of staff in just over three years. The natural consequence of this is the difficulty in assuring a consistent and continuing school culture and approach to teaching and learning, particularly if the school wishes to embark upon an agenda of change and innovation. The professional development issues alone are significant. More concerning, however, is the belief that young teachers coming into the profession in these circumstances will tend to be left on their own to survive with few experienced and innovative mentors. As a result, and sometimes as a matter of professional survival, they tend to teach the way in which they were taught. As Wood suggests:

> The fear is that young teachers come into the profession and may remain fixed in a traditional pedagogical approach, an approach that will remain unchanged throughout their careers.

It is clear that in order to effect major changes to the way in which ICT is utilised to enhance teaching and learning, issues of teacher shortage need to be dealt with. The government traditionally carries out a curriculum and staffing survey every two years, the current one is now two years overdue. The lack of a report prompted parliamentary questions in February 2002 from the Liberal Democrats demanding to know the reasons for the delay. Ironically, the Government says that the report has not been carried out due to staff shortages (Curtis, 2002, July 4).

Nonetheless, it also evident that the Government clearly realises that without a stable and well-trained teaching force there will be limited opportunity to effect the systemic change to the education system that they envisage. As Miliband asserts:

> The recruitment and retention of good quality teachers underpins our reform agenda. Without good teachers we will not transform our education system (Department for Education and Skills, 2002b).

Clearly, the issue is that innovative uses of ICT are unlikely to occur when teachers in classes are inexperienced or lack comprehensive content knowledge in a specific subject area. This is further compounded, too, when teachers are inexperienced in teaching or limited in their command of a range of different pedagogical strategies demanded for effective uses of ICT in learning situations. Additionally, if teachers struggle in matters of behavioural or classroom management, while also having limited command of content and a restricted suite of pedagogical strategies, it is unlikely that they will be able to confidently implement new modes of learning predicated on effective uses of ICT, let alone innovate. Arguably, wide-scale and effective systemic

transformation of teaching and learning cannot occur in an environment in which there is such an endemic teacher shortage.

Outcomes from the New Opportunities Fund (NOF)

One of the keys, therefore, to ensuring that there is a significant take-up in the classrooms comes from empowering teachers with the skill, knowledge and understanding to transform their learning environments using ICT. Another visionary initiative of the Labour Government to facilitate this has been the NOF; a Lottery Distributor created to award grants to education, health and environment projects throughout the UK. NOF has deployed £230 million since 1999 to train teachers in ICT skills and thus seek to improve the quality of learning outcomes in classrooms. The specific aim of this training is to ensure that teachers and school librarians are equipped with the necessary knowledge, understanding and skills to make sound decisions about when and how to use ICT effectively in teaching. There is also £20 million available to train public librarians in ICT skills.

The OFSTED report, *ICT in Schools: Effect of Government Initiatives*, however, is equivocal about the success of NOF in effecting real and systemic change in the ways in which teachers are constructing improved or changed learning environments:

> NOF training remains unsatisfactory in its overall effect. Training in around six out of every 10 secondary schools and half of the primaries has so far failed to tackle adequately those issues relating to the quality of ICT use in classrooms. Training materials for specific subjects at secondary level have often failed to excite teachers. In many secondary schools, the programme has simply ground to a halt. (OFSTED, 2002)

Despite this criticism, the report does note some improvement in NOF training and also suggests that the involvement and interest of senior management in a school have a direct effect on positive outcomes. Further, the report suggests that, “Teachers left to their own devices, to use distance learning materials in their own time, rarely make the same headway”.

Perhaps of most concern in the report is the assertion that:

> …there are still too many teachers who struggle with an unfamiliar technology and are sometimes apprehensive about using it. These teachers in particular need good professional support to help them move forward. The training funded by NOF fulfils this role only partially, and continues to disappoint many teachers.

Arguably, NOF was never designed to directly address ICT as a classroom tool but to raise the skill levels of individual teachers so that they could be empowered to proceed to the next step of redesigning curriculum and utilising ICT in the classroom. However, these OFSTED findings suggest that although there has been an improvement across the country in teachers’ ICT skills, outcomes are very much dependent upon the experience of individual schools with individual providers.

This view is confirmed by McMullan who suggests that many teachers today still see the implementation of ICT as a burden (McMullan, 2002). Baines concurs and offers similar criticism. He also suggests that issues of poor delivery by training providers have also been a major issue – something endorsed by the OFSTED report. Tellingly though, Baines also suggests that the people who have taken up the technology would have been likely to have done so anyway, with or without NOF. At the core of Baines' concerns however, is his belief that NOF has not offered any lead or encouragement to teachers to reform their pedagogies. As he suggests: "It is difficult to avoid the conclusion that profound transformation of teaching and learning is not part of the agenda" (Baines, 2002).

It is clear, nonetheless, that success of NOF programmes is consistently greatest in those schools which are well-resourced in ICT and who have the clarity of vision in how ICT might transform teaching and learning. But as is also clear, success of the programme is not system-wide. Initiatives such the Laptops for Teachers scheme through Becta and announced by the former Secretary of State for Education Estelle Morris in 2002 may address some of the issues relating to both teacher access and confidence to take up the technologies. Laptops for Teachers funds 100,000 laptops for teachers across England. LEAs will purchase the laptops and schools will allocate them to teachers for their use. It may be that coupling this strategy for significantly increasing access for teachers to ICT with continuing NOF programmes will see further developments in teacher facility with the technologies.

The tension between schools, LEA and national policy

In this context, however, it appears that there is also variability amongst LEAs and their effective commitment to the implementation of ICT in schools. This variability encompasses clearly stated corporate vision and strategic plans for ICT through to the provision of support to schools and senior managers (OFSTED, 2002). A core concern is that although there has been "a positive shift in LEA support for ICT away from infrastructure towards its use in the classroom to enhance teaching and learning… weaknesses remain in a significant minority of LEAs" (ibid). Nonetheless as Wood unequivocally states in interview: "In Kent there is no coherent plan across the authority".

Against all of this, there appears to be a tension between a culture of autonomous, self-managing schools which empower headteachers with the responsibility for change and innovation, and the mandated national reform agenda. As a result, the implementation of government policy initiatives is very much dependent on individual heads and their staff and the success of any innovation or improved practice rests upon the leadership qualities and vision of the headteacher and the culture and climate that he/she creates in order to foster and encourage change.

In interviewing the headteachers of three innovative schools, it was apparent that their clear sense of vision and their entrepreneurial leadership styles enabled them to maximise the policy initiatives with which they were presented. All three articulated eloquently their sense that the driver for reform and change in the learning environment was not ICT, but a need to radically reform what it is that their schools do. As Walsh puts it, underpinning all the reforms and changes to teaching and learning at King Edward VII, lies a commitment, a vision of learning "in which the learning agenda is put in the hands

of the individual student". Furthermore, he states that the vision is "driven by theories of learning that cannot be ignored". Hence, at King Edward VII there is deep commitment to the professional training of teachers, not only in ICT, but also in all aspects of learning. This is manifest in the establishment of the unique role of training manager, responsible for the proactive and responsive co-ordination of professional development of teaching staff in everything from word-processing to behavioural management. It is also evident in the appointment of para-professional learning resource assistants to support professional teachers by developing online and conventional teaching resources.

Similarly, Alan Stevens at Sawtry Community College suggests that reform and change were driven by a vision of the school that transcended its traditional incarnation as a learning institution for children. Instead, the school saw itself as a learning centre, providing learning opportunities for the whole community. This transformed conception of the learning environment, infused with ICT, provides the mechanism to unhinge the learning opportunities from the confines of the school's physical campus.

At The Cornwallis School, Mike Wood perceived the power of ICT to transform the learning environment but stepped back from mandating school-wide change. Instead he has pursued a path of creating a culture in which classroom innovation is supported and, indeed, celebrated. It is culture of risk which celebrates risk-taking: "The capacity to respond to changing trends and to be prepared to take a risk, to acknowledge the fact that the answers are not clear – to recognise that this is an opportunity". This view is supported by Walsh, who argues that schools "need to provide a supportive culture in which individuals (staff and students) can take risks and engage in innovative practice".

Each of these three headteachers is responsible for a very different school. In each case, they have responded to the demands and limitations of their contexts to create innovative and successful programmes that seek to utilise the power of ICT to serve teaching and learning. What characterises them though is their capacity to explore the possibilities presented to them by national initiative. Arguably though they are the kinds of educational leaders who would have been innovative in their schools anyway, with or without policy dictates. They are successful products of the devolution of authority and responsibility that occurred as a result of decisions towards school-based management in the 1980s and 1990s.

Yet as Walsh points out, the changes that schools such as his have implemented can challenge the prescriptive, content-driven curriculum defined by the LEA that the school is expected to follow. At the same time, too, there is a reluctance to embrace 'silver bullet' educational solutions that predicate a 'one-size fits all' curriculum. Innovative practice can also be compromised, Wood suggests, by externally mandated examinations which privilege particular and often limiting approaches to learning. There are clearly tensions that exist between innovative practice – even when it is successful and acknowledged – and the broader expectations of LEAs and indeed national policy directive.

Nonetheless, these schools are seeking to respond to the thrust of the national policy directives by exploring what is possible in transforming learning, especially with ICT. They have done so in different ways and been governed very much by their unique

contexts and school cultures. But what of other schools and the manner and ways in which they have responded?

It is apparent that the strengths of the schools described above lie primarily in the vision and entrepreneurial nature of their headteachers. They have established and developed cultures which endorse innovation and privilege risk-taking in effecting change. In so doing, they reflect the best of devolved, school-based management. However, system-wide autonomy for school leaders also brings with it significant complication. It is clear that some schools may cite autonomy as a reason to not act. Resistance to change can be justified on the basis that authority to run the school has devolved to the headteacher.

Whatever the case, there is a clear tension between a growing trend towards education policy being driven by national government and the role of the LEA and the devolved management of individual schools. It is not surprising, therefore, that for this reason alone, there is limited system-wide innovation in teaching and learning and inconsistency in use and application of ICT.

Innovation and school design

Core assumptions

The complex matrix of reasons that appear to inhibit reform of UK schools is not unique. The history of school reform is dogged with similar stories of government and private initiative foundering as a result of similar issues and challenges (see for example Caldwell, 1997 and Gipson, 2001). Consistent among the criticisms levelled at reforms linked with ICT in the UK has been the belief that, as Wood puts it, too much emphasis has been placed on numbers of computers in school and notions of connectivity. Too little, he suggests, has been placed on issues of teaching and learning.

Yet ICT is simply one of many reform drivers. It is also only one of the many expectations and demands that have been foisted upon schools. Indeed, the decline over the last twenty years of social agencies such as the Church, neighbourhood and family, has led to the expectation that schools take on more responsibilities and adopt a more holistic approach to education, embracing the social, spiritual, pastoral and moral dimensions. This in addition of course to their continued focus on academic achievement.

In a school day, where there are so many real demands on time, there is scant opportunity to effectively provide for professional development for teachers to address all of these areas, let alone train for technology and indeed for curriculum and pedagogical reform. What we end up with is a case of reform gridlock, where the competing forces begin to cancel each other out and we are left once again trapped in a position of stasis.

School change and school reform, has been likened to redesigning a jumbo jet in flight, or changing the wheel on a moving car (Dimmock and O'Donoghue, 1997). So how can real change and sustainable reform be effected? It is true to say that many attempts at reform have been top down driven, dictated by policy-makers at the highest level, and as a result they seldom make an impact in the classroom itself. The current context in the UK reflects this. What is needed is a methodology which anchors concepts of efficiency and effectiveness in classrooms with teachers, yet which provides a set of generic principles that accommodates the unique contexts and cultures of individual schools.

Arguably too there is a real need to develop 'quality' education, personalised for all students regardless of ability, an education that specifically and professionally addresses their learning histories, intellectual characteristics and learning style preferences (Bain, 1997). In order for this to occur, schools need to become more viable learning organisations by becoming more tightly coupled, intentional and professional places.

Definitions of school design

Dimmock (2002) asserts that many of the changes that occurred in education around the globe in the 1990's "occurred at levels beyond the classroom and the day-to-day experiences of learners". At the turn of the millennium, he argues for a redefinition of the process and principles of changing school environments, for a more sophisticated understanding is required of the complex interconnections and contexts that constitute

school cultures. To this end, he suggests that school improvement focus much more upon principles of design than on restructuring:

> The term 'design' implies a deliberate strategic intention to craft – using a set of tenets or principles – a plan or blueprint for changing the various interdependent elements that make up a school – with the purpose of achieving school improvement aims and objectives. (Dimmock, 2000) Thus defined, the concept has a number of attractions. First, unlike the term restructuring, 'design' explicitly involves principles or tenets as guides for ensuring coherence. Secondly, there is deliberate intent to architecture the organisation so that it achieves certain desired improvement goals. Thirdly, the term implies a degree of coherence and interdependence between the different elements that go to make up the school. In short, 'design' has connotations of a more intentional and sophisticated process to re-shape schools according to a set of design principles, which includes a knowledge base of 'what works', 'best practice', or preferably 'informed practice'. (Dimmock, 2002)

The implications of this go much further than change as a result of mandated curricular or pedagogical reform. It suggests that individual schools need to respond to their own particular contexts in an intentional, highly rigorous and well-researched way. As a result, they may address the particular and unique learning needs of their school community. Dimmock, however, argues in an earlier work, *Designing the Learning-centred School: A cross-cultural perspective* (2000), that it is nonetheless possible to describe generic principles or tenets that underpin this notion of school design, all of which seek to address the complex and highly ambiguous, loosely-coupled cultures of schools. At the core of the learning-centred school are the twin assumptions that:

> …first, students of all abilities deserve a more individualised education, one that specifically addresses their achievement histories, intellectual characteristics and learning style preferences; and second, that a school needs to be more tightly coupled as a professional learning organisation. (Dimmock, 2000)

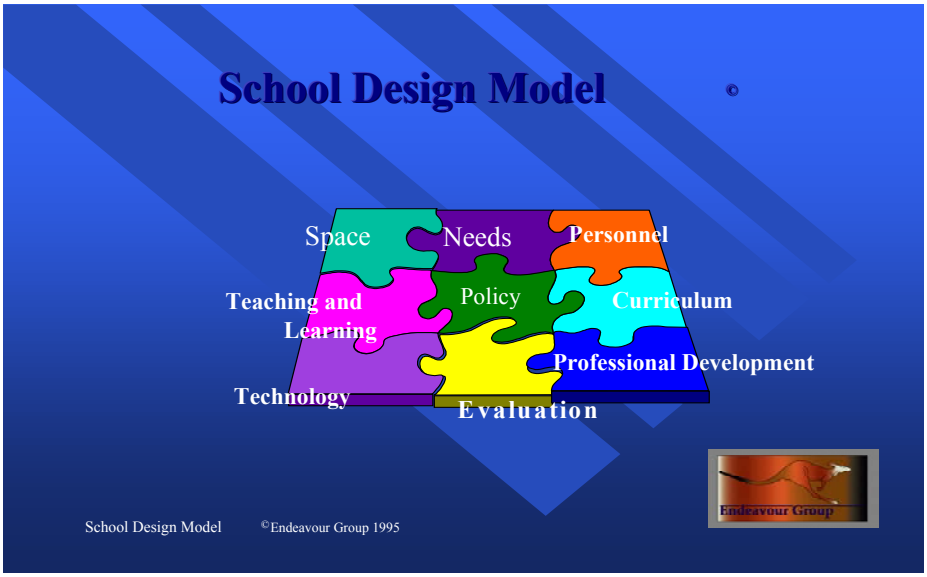
All activities and structures of the school, curricular and administrative, are then referenced back to these assumptions. The key questions asked should always be how actions or structures advance the individual learning achievements of students, and how actions serve the process of teaching and learning.

There is not space in this paper to fully describe the essential characteristics of a learning-centred school as Dimmock defines it. However, it needs be noted that creating the learning-centred school does involve the close connection and articulation of:

- being outcomes driven, with differentiated curriculum and teaching materials integrated with informed teaching practice
- teachers working in teams
- technology being embedded in all aspects of school activity
- physical space being configured to permit diversity of pedagogical strategy and activity

- clearly described position descriptions for all staff
- administrators also performing as instructional leaders
- systematic and continuing professional development of teachers

Bain (1995) suggests that this kind of model of school design can best be represented pictorially thus:



Each component of the school can be seen to be directly connected (or coupled) to the others. Each part mutually reinforcing the other. All pieces combine to provide the final picture that the jigsaw represents: an image of an effective, tightly-coupled school design focused on student learning.

The simplicity of the tenets of the learning-centred school design appears to belie the obvious complexity of individual school contexts and cultures. However this is not the case, for at the heart of these principles lies the inherent recognition that schools are, by definition, complex places, beset by individual (and often individualistic) cultures. Hence, the school design process constitutes a set of core assumptions and guiding precepts that permit a particular approach to school improvement that acknowledges the uniqueness of school contexts. What is distinctive about this design process is that it seeks to impact upon the core business of schools by placing teaching and learning and the needs of each individual student at its core.

Approaches to school design in this manner are not idealistic. The transformation of Brewster Academy, New Hampshire, detailed in *The School Design Model* (Bain, 2001), describes the process of school improvement utilising the principles that Dimmock describes. Further, the transferability of Bain's design heuristic to schools in Hong Kong is also noted. Schools in Thailand and Australia have also employed the principles of learning-centred design to establish or redesign schools (Gipson, 1999; 2001).

School design and the UK context

It appears that the principles of learning-centred school design may provide opportunities for a 'third way' in assisting schools to address the drivers for change and reform. As has been suggested, there are two dominant, and often, oppositional models of school reform. On one hand, top-down, government-led, systemic mandate; and on the other, local, school-based and context-specific individualised change. Clearly the Labour Government in the UK has a clear set of goals and imperatives for educational change, but as has been seen, this is highly dependent nonetheless on the specific leadership skills of individual headteachers, as a result of a history of devolution of authority and responsibility to school-based decision-makers.

This is particularly evident in the dominant current reform initiative: the implementation of ICT in schools as a means to transform education. The predictable systemic failure of this resides in a complex matrix of competing and conflicting issues detailed extensively above – from teacher shortage to limited professional development, to access and connectivity. It is evident, however, that despite the millions ploughed into the initiative, little impact has been made systemically on transforming teaching and learning in classrooms across the country. Arguably, despite the rhetoric and the investment in ICT and in associated professional development, insufficient strategic attention has been given to referencing these reforms to the core focus of teaching and learning. Further, only limited attention has been given to re-engineering schools to maximise the opportunities that ICT promises and which have been experienced elsewhere (Baines, 2002).

Certainly, there have been enormous strides since the late 1990s in terms of internet connectivity. Initiatives abound at governmental, LEA and school level ensuring that teachers, students and their families have increasing opportunity of access to ICT. Nonetheless, it is argued that the majority of these initiatives simply graft the technologies onto existing practice – there are few examples of intentional, learning-centred school design.

Conclusion

The investment in the implementation of ICT in education in the UK has been significant. There have been many successes, but little systemic impact has been made in genuinely transforming the teaching and learning environments of individual classrooms. The reasons for this are complex and manifold and reflect experiences around the globe in issues of school reform and improvement.

It is, therefore, tentatively suggested that the principles of the learning-centred approach to school design be considered as a direction which all schools should follow. The precepts underpinning the design approach celebrate the importance of each individual school's unique culture and context, yet at the same time provides a highly articulated, tightly-coupled approach that sets teaching and learning at the core. Predicated at a systemic level, it provides a common philosophy and set of guiding precepts, yet allows for regional individuality.

This suggestion is not a panacea. It will not solve issues such as teacher shortages, nor will it provide immediate resolution of inconsistent equity of access or connectivity. What it may provide, however, is a much more strategic approach to achieving the laudable goals of the UK government in raising the quality of educational provision. The role of ICT in transforming education must consequently be seen in its context: simply one of the constituent elements of effective school design. It should not be the driver of change, but one aspect of an approach to education that provides enhanced opportunities to serve its core processes: teaching and learning.

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