Managing Information and Communications Technologies in South African Education

Final project report

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Summary

This was a meta-study. That means that the intention of the study was to review and analyse previous studies, and draw conclusions about the state of research into technologies in education, and specifically into the management of those technologies.

The project proposed a range of objectives that were reduced because of funding limitations - the reduced project scope focused on an extensive *literature review* (the bibliography) and the development of a *reference model* that is intended to guide those concerned with managing ICTs in South African education (whether as managers or as researchers). The original proposal also included the development of *case studies* and the establishment of a *knowledge base* (built around the reference model) but this work remains to be done.

The project was somewhat problematic in execution. Resourcing and administrative difficulties resulted in no students graduating (yet), and this is a matter for disappointment. These problems were reported to the NRF and – in the end – useful outputs were achieved.

First, following establishment of the project, a two-day meeting of about 20 experts revealed a consensus: that the many *differences* that are to be seen (in learners, teachers, resource levels and other factors) are probably the most important thing to acknowledge and respond to, in undertaking further research into technology in South African education and in improving management practice. The drivers for change arising from technological innovation are forceful, and the form and function of education establishments is changing. In the simplest possible view, information technology is an investment and it needs to be managed accordingly.

The idea of *value* can be used to develop logical connections between the sometimes-uncontrolled cost of education information technologies, and the strategic benefits that are sought for learners and for the nation. Critical to understanding how value can be assured is to acknowledge and pro-actively manage the *information systems* that are the means to improve educational processes, and the *benefits* that must be defined and then delivered, if the investment of time, money and effort is to be worthwhile.

The *bibliography* that emerged from the literature review (more than 160 papers were read, being chosen from more than 700 candidates) confirms that *there is little evidence that the management of IT investments in education* is researched. Further, while some reported work makes passing reference to (or implies) strategic management, *there is little evidence that strategic options and strategic management techniques are being seriously researched* at the regional or national level.

To deal with the problems of technology and strategy management:

- The *diversity* that we live with needs to be understood and incorporated into policies and strategies for information technology and information systems in education.
- The role of the *stakeholder*, and existing techniques for *stakeholder analysis*, will be key in determining the value is sought from our information technology investments in education.
- There is more to this than just teaching and learning. *Research* is a key feature of the education landscape and needs good information technology support; *administration* at all levels needs good systems, and *management* needs management information that provides a basis for good decision making.

The *reference model*, currently focused on "Teaching and Learning" as the core educational activity, organises the chain of value that begins to ensure successful investment. It also shows how knowledge management fits into the "big picture" and it provides an ontological foundation for further work, as well as a framework for the evaluation of performance and value delivery within working education institutions.

The project also developed significant ancillary outputs: a proposal for a *special issue of a journal*, a *"Flash MOOC"*, and a *qualitative research data analyser*. The project contributed to a new book, "Investing in Information", that is to be published imminently by Springer in Geneva (and that provides much more detail about the idea of value management from information technology investments). A number of *journal papers* have already been published, and further papers are in process.

The main body of the report that follows is just 15 pages. The remainder of the report comprises appendices that augment the summaries in the main body, and provide some evidence about how the conclusions were reached.

Contents

Figures

Introduction

Initial objectives of the study

The initial aims and objectives of this project[1], against which its success can be judged, fell into six areas, as follows ...

- Project management
- Literature review
- Case studies
- Reference model for ICTs in education
- Knowledge base
- Closure

Project management

To organise and maintain a detailed project plan, and to provide progress reports.

Good project management assures the integrity and purpose of any study.

Literature review

To undertake a meta-study by means of an extensive review of existing work, and current literature concerning ICTs in education.

This was essentially a desk study, and it discovered more than 700 potential journal articles (and other sources), of which more than 160 were reviewed in detail.

Case studies

To analyse the role of ICTs in education from two points of view:

- teaching and learning (imparting knowledge), and
- through all stages of the educational system (accumulating knowledge).

It was also intended to develop an analysis of *categories* of ICTs that are potentially useful in education, and the areas of application of those ICTs, taking account of both perspectives.

[This objective was put on hold because of the limited funding that was provided – see below.]

Reference model for ICTs in education

Develop a reference model that will:

- Summarise the key elements of ICTs in education in a conceptual model
- Make clear the opportunities for ICTs to be beneficially applied
- Clarify the perspectives of the different stakeholders involved

A reference model is a high-level view of a domain of interest that organises the principal components within it, so as to enable productive discussion and development of such a domain, involving all interested parties. Such a model establishes a "universe of discourse", rendering efforts to establish norms, standards and "best practice" more productive and more useful.

Knowledge base

Accumulate knowledge about ICTs in education and locate it in a body of knowledge that will:

[1] All critical documents setting out the project and its objectives can be found at the project web site: http://saicted.wikispaces.com

- Disseminate the results of the study to interested and involved role players
- Promote the outputs of the project as teaching material for advanced studies in education
- Test the efficacy of the body of knowledge in practice, and to stabilise its operation and management

Such a body of knowledge would be organised and indexed around the Reference Model, making it not just a collection of knowledge but a *structured* collection of knowledge that can be explored according to that structure.

[This objective was also put on hold because of the limited funding that was provided – see below.]

Closure

To ensure that the project is completed and all intended outputs are delivered, and to gather the lessons learned and make them available for future research.

Execution of the project

Refinement of the objectives

At the first project meeting, during a discussion of the objectives, some focus was found according to what were considered to be dominant current issues. It was agreed that the management issues were indeed predominant:

- ICTs are installed in schools in SA already but they are not universally effective; *how do we use them better*?
- ICTs are potentially accelerators of educational processes, but *how might it be possible to achieve that*?
- We need to spend money on ICTs more effectively, what is the quality of strategic thinking, and *are the intended benefits of ICT investments in education clear, and agreed*?
- How can we ensure *an educational return* on our investment in ICTs?

Funding

The funds awarded by the NRF comprised only 25% of what had been requested, and therefore the scope of the project plan had to be significantly reduced. It was agreed that the **Case studies** and the **Knowledge base** should be left over until the **Literature review** and the **Reference model** were complete.

Resourcing and project management issues

Of the funds made available, about 70% was earmarked for student bursaries – a greater proportion than had been requested in the proposal. The funds available for non-bursary purposes were therefore further reduced, and when it came to registering the four students (one doctoral, three masters) there were difficult administrative issues that arose from the timing of NRF and CPUT procedures. It is worth a moment to place these difficulties on record, not so as to "complain" about anything, but to provide some insight into how management difficulties in a young tertiary institution can jeopardise a research project such as this one.

At this time CPUT required applications for registration to be lodged with fees paid *before the end of February*. However, the NRF were only able to accept nominations and make funds available for registration payments *in May*, which itself required proof of registration, which required payment of fees ... a classic "Catch22" situation. In short, because the students had no funds, and no other

funds were available for the purpose, there were extensive delays in getting started and intervention from the CPUT executive was necessary in order to break this simple administrative log jam[2].

A separate problem concerned the appointment of the post-doc team member. The selected candidate, Dr Nhlanhla Mlitwa, started to make arrangements to re-organise his workload, but it was realised (or decided?) that as *an existing employee of CPUT* he would not be allowed to take up the bursary, and permission to appoint him was thereby denied. An alternative appointment was only possible more than half way through the project.

All of this difficulty in making appointments and registering students came at a time when the project actually needed a high level of nurture and care, in its early stages.

Worse was to come. Professor Andy Bytheway, the leader of the project, was a part-time, retired employee at CPUT[3], remunerated on a one-year renewable contract. At the start of the *second* year of the project his contract was not renewed, because of new CPUT executive policies. For four months, from January to April, he received no remuneration at all and the project had to be put on a "minimum care" basis. Once again, there had to be appeals for clarity and executive assistance at a time when the projected need total attention to its intended purpose, and when students needed support in order to finalise their personal research proposals and to register for their second year.

Hence, both the project leader and the appointed research students had a torrid time, completely distracted by the problems of administration when they should have been busy teaching and learning the craft of research.

Because of the significance of these problems, the students were later surveyed independently in order to establish their feelings about their involvement with the project, and the institution. The survey confirmed that the administrative difficulties were a major motivational problem, and that they felt distant both from the institution and the project. The doctoral student withdrew because of personal circumstances (health issues in her family), and two of the masters students withdrew – one because of a change of employment circumstances (moving to Durban) and one because of capacity and capability. At the time of writing, it is understood that the third masters student is still intending to complete the master's that she has started.

All of these difficulties were recorded and reported at the time, and there was one special meeting with the NRF at which things were explored in some detail. More information can be made available should it be required, but we are left with a strong feeling that the administration of post-graduate research activities at CPUT needed to be reviewed and improved. Postgraduate students simply cannot be treated like undergraduates.

Happily, in the final analysis there are some very positive outcomes from the project. One of the early major events was a two-day meeting of local experts, at which the issues seen in managing and researching technology and systems in education were thoroughly discussed.

[2] To give an indication of how problematic this was, more than 150 email exchanges are "on file" that were trying to deal with this problem – more than two per day on average for the whole of the period in question.

[3] The original NRF invitation to submit proposals *specifically suggested* that retired researchers could apply …

Getting started: a meeting of experts

In January 2013, a group of academics (and others) involved with education in South Africa met, to discuss the educational impact of information and communications technologies ("ICTs", referred to here as "education technology" or "education systems"), and the need to *manage* educational technology investments in a more thoughtful and effective way[4]. Each of the four tertiaries in the Western Cape was represented.

Four questions guided the initial approach to the discussions:

- what does "management" actually mean in the educational context?
- what "value" is there in using technology in education?
- how will "good management" deliver that "value"?
- what are the "factors" that lead to management success (or failure)?

Discussion of the results of the meeting

One of the principal results of the meeting was an agreement that *differences* are possibly the most important issue faced by education management.

There are differences in everything

Different people see technology differently. Mobile devices are not seen by children in the same way as adults. To a child a smart phone is something that serves multiple functions; to an aged retiree they are likely to be seen as an unnecessarily complex telephone. Digitally literate people will see the same functionality and capability in different kinds of technology, especially (for example) when the technology provides browser access to the World Wide Web, be it a smart phone, a desk top computer, a public information kiosk, a tablet or a netbook despite the significant differences that exist in modern digital technologies. The contexts within which education is delivered are different, the languages used are different and the motivations and attitudes of key stakeholders are all different.

Some agreements

Some important agreements that came out of the meeting are as follows:

- **IT is an investment**: Investments in information technology in education are not delivering the expected benefits, and there has been little research that deals with this at a managerial level. Understanding the benefits of information technology in education requires that we understand its *value*, as seen by different stakeholders. The very structure of education is changing. Children in wealthy families are switching to home schooling, exacerbating the divide that exists between rich and poor; at the other end of the scale courses are now offered globally, with tens of thousands of learners all registered at the same time, and at little or no cost. This radically changes the choices available to learners and it expands the stakeholder groups who are involved.
- **Connectivity is driving change and complexity**: Younger people are now constantly connected to the Internet and the World Wide Web. Timescales, time horizons and information boundaries are all being redefined. Hence, the extent and depth of change is significant and worrying, and this can obscure the useful opportunities that do exist. Problems relating to information technology in education include added complexity and the general challenges of managing change.

[4] A full report on this meeting is available at the project web site: http://saicted.wikispaces.com

- **Change is turning education upside down:** It is widely accepted that technology can turn regular businesses upside down (and inside out!) and this is true in education: teachers are no longer the necessary source of knowledge, rather they have become the managers of processes that bring education resources much closer to the learner, and that enable access to (and assimilation of) a vast range of knowledge. Complexity derives from the differences in teachers, learners and contexts, one size will *not* fit all. Learning might be fragmented, but technology can join it up. Strategic management is needed but educational "leaders" will still lead, and "laggers" will still lag.
- **Managed change is possible:** Change can be achieved progressively, by recognising that *early* benefits are concerned with *efficiency* (taking a minimalist approach to change); later benefits can be concerned with the more challenging issue of *effectiveness*, demanding more committed approach to change management. At the heart of change is the finer and finer "granularity" of education. Technology changes quickly, attention spans are shorter, periods of learning are shorter, sources are more numerous, more diverse and compact. The drivers for change include the technology suppliers (who drive the pace of technology change) and the learners themselves (who expect a rapid pace of learning).
- **It's all about delivering timely value:** Education is a key stage in the "value chain" that generates and delivers new knowledge, wherein (with information technology):
    - Research can be more immediate
    - Publication can be instantaneous
    - Learning is driven more by learners
    - Assessment of learning is assisted by technology (but still needs expert judgement).
- **People give up too easily:** This is true of teachers and learners. There are signs that some educators are leaving the profession because they cannot face the changes that are at hand. This can happen for two reasons: first an educator may decide that what is happening is dragging him down and he deserves better; alternatively an educator may decide that it is all too much, they are sinking, and they then leave in a crisis of confidence. Learners adopting the new online mode of learning are found to be much more likely to drop out than those in traditional modes of learning. The management challenge is not just about the complexities of technology, it is about the moods and attitudes of the people who are involved.

Key themes

Before moving on to some of the specifics of the research project itself, it is useful to set the scene a little more carefully by drawing themes from the record of the meeting of experts, that come from further reflection on the two days of discussion:

- The current need for *systems*, not just technology
- The impact of technology on *society at large*
- The *specific pressures* for change on education
- The problems of *managing change*
- The pressing need for *effective management*

The need for *systems*, not just technology

Technology does not "add value" of itself, in that it makes education better in some way. It merely provides convenient access to information and the means to process it, and hence it enables activities to go "online" that are thereby improved and are the real source of value.

But it is not all good news. People who work (or play) on the Web can be identified and tracked through their usage: hence *identity management* has become a critical issue – a problem for some, but an opportunity for others. People who have more than three or four email addresses, dozens of identities on the many web sites where they are registered, multiple SIM cards and passwords

beyond recall, all now struggle to manage the ways in which they present themselves in the different realms of their personal and working lives. This is not adding value. Worse, there is the distinct possibility that tracking data will be misused. Technology is driving us to a complex personal place that we had never anticipated. Technology should be helping us with services that save us time and effort, but more often it is compensating for mediocre bureaucracy or tempting us with marketing gimmicks – it does not necessarily solve problems. It should support a relationship (or relationships) between different parties who need to work or live together and where technology is sympathetic to these kinds of relationship it works well – where it subverts relationships it can cause them to fail, and this is as true in education as it is elsewhere. Supporting relationships with technology requires a recognition that we need *systems* to organise the multifarious technologies in ways that suit the way we live, work and play. And learn. An information system is an engineered solution to real needs that brings together the hardware, software and communications technologies with the people who can operate and benefit from it. In the present narrative we will refer to information systems used in education as *education systems*.

Society at large: the social web

One domain which brings technology and systems tightly together is the social web: the special-interest community web sites, the social networking web sites, and the blogging and publishing web sites that enable instant sharing of information, opinions and visual material. We cannot confine our concerns to the educational value (or challenges) of these social networks, it is necessary to recognise that for young people (and some older people) they are a permanent and defining feature of life. For much of their time they see the world solely through their computer and smartphone screens, and they have an attention span that is measured in seconds rather than minutes or hours. This cultural change can of course be seen in learners. In many places it is the learners who are pressurising teachers to bring the technology into their teaching and learning. It is the new norm.

In this new world of connectedness, the question of personal identity and identity management becomes hugely important. How do we know that our correspondent (who we have never met, and will probably never meet) is not really a pretty young teenager but a middle-aged man? For that matter, how do we know that the “Bank of Central Lithustonia” really exists?

We all need to get much smarter at spotting the fraudsters and identity thieves well before we get into trouble. Potential employers are almost certainly going to use these networks to learn more about job applicants and they will get better and better at doing this. People must be made aware of the use, abuse and personal risks of the public domain that is the Internet. Digital citizenship is not just an idea, it is a real force for change and it constantly reshapes the digital divide.

Back to education

How does this all reflect in education? Can we turn education upside down, as businesses are doing within their supply chains? Is it already happening?

Yes. In education we already know that many teachers are no longer the “fount of all knowledge” in the eyes of their learners, rather a teacher is a *manager of a process* that acquires knowledge from independent sources.

At the first, simple, level we can conceptualise the use of technology in education as follows:

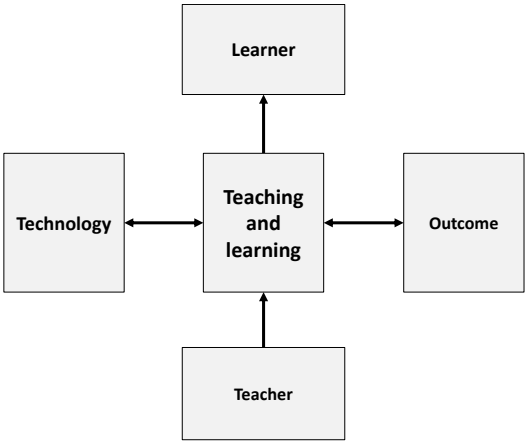

Figure 1: Teaching and learning as the core relationship between teachers and learners

If the application of technology to this relationship is to be beneficial then we need to understand what it is that teachers and learners are trying to achieve, and how the technology might contribute on both sides. But things are constantly changing: teachers come and go, learner attitudes change, and of course the technology changes with breath-taking rapidity. Change management becomes our concern.

The problem of change

Technology moves so fast and education is constantly trying to catch up. So much so that educators can lose sight of what is actually happening in education because of what is happening with technology. It is ironic that in the Western Cape, after more than ten year's hard work, some 1500 schools have finally all been provided with "computer labs" (Khanya Project Team, 2011) just when everyone wants to own and use a "tablet" computer. Perhaps there is an impossible difference between the time horizons of education and the time horizons of technology suppliers that will always confound us (one year in education, just weeks in the technology industries) – we need to be able to "future-proof" our educational investments and manage the problems of change constructively. Dealing with change requires strategies, and strategic management.

The need for management

This picture of wholesale change is not yet the subject of careful strategic management. Some would say that in South Africa our system is very rigid, and that change is difficult, but the truth is that our educational systems are constantly in change in certain ways. Four Ministers of Education in recent years have caused four different curricula designs. Can we not agree what we are educating people *for*, and then let teachers decide *how* the education will be achieved? Unfortunately, sections of the teaching workforce are, seemingly, not interested in the kinds of change that will benefit learners, and make the best possible use of education technology and education systems.

Summary

In this way, the meeting of experts useful foundations for the work that followed in the project. The following main sections of this report now present the principal achievements of the project at the level of the **Bibliography** (an extended literature study) and the **reference model** (a conceptualisation of all that has been learned during the project). There are other ancillary outputs from the study that are then introduced, for example it was agreed at the meeting of experts to launch a "Flash MOOC", and to develop a special issue of a journal focusing on the issues – more about both of these ideas will be found later in this report.

Principal achievements of the study

The bibliography

The review of published literature discovered more than 700 candidate articles, of which 639 were inspected and categorised according to their content (relating to *management*, *education*, and *technology*), their origin (by *journal title* and by *country*), and their potential relevance to the project. Of these, 163 were read, annotated and evaluated, and included in this report (see the extended discussion of the bibliography in Appendix 1 and the complete listing of references in Appendix 5).

Year of publication

It is important to understand the age of the literature that has been reviewed. Generally the articles were published within the last 10 years, but there were one or two (having particular significance) that were older. The actual distribution over the years was as follows:

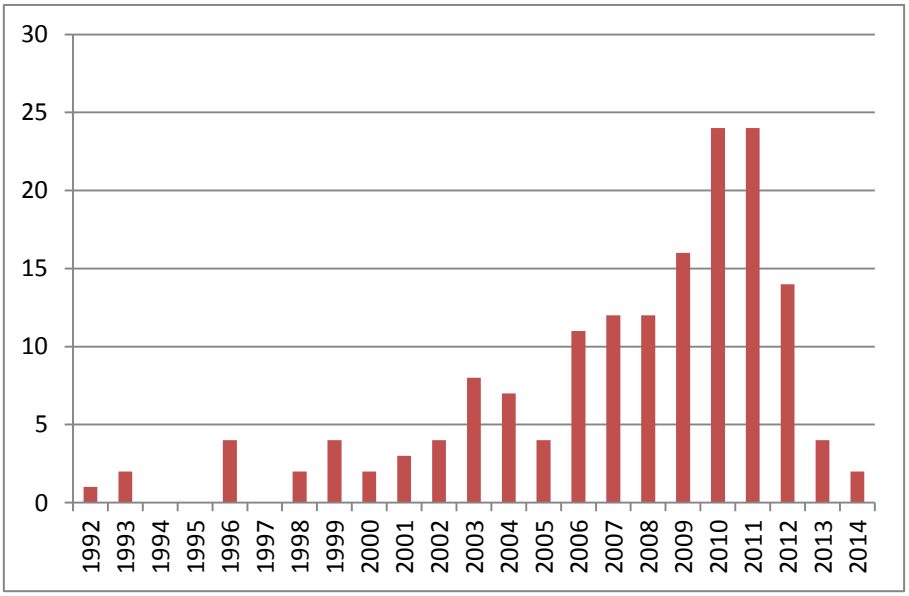

Figure 2: Distribution of selected articles by year of publication

Some outcomes

It became clear that there was a sufficiently large body of *management*, *education* and *technology* literature that *might* contribute to such a review, that it would be impossible to include it all. Nevertheless, a great deal was learned about undertaking a meta-study such as this and there are some conclusions:

- **Things are changing:** There is considerable evidence that in South Africa the ability of many education institutions to accommodate and successfully manage change (at all levels) is very limited.
- **The statistics:** Surveys confirm poor overall educational performance in South Africa, but some of the good stories *from individuals* are indicative of what can be done.
- **There is diversity:** Differing capability, experience and outcomes in South Africa make clear the need to deal with the differences that are to be found: in technologies, and in teachers, learners, communities and contexts. "One size" does not fit all.

- **Maturity is a major issue:** There is clearly a life-cycle that reveals the different needs of managing ICTs in education over time.
- **Perceptions are just as important as reality:** Statistical research can easily mask this truism, whereas case study research digs deeply into people's attitudes and perceptions. Managing *expectations* and *perceptions* is more important than managing *actuality*.
- **Stakeholder issues are significant:** Techniques for analysing the needs and expectations of stakeholders are well established in the management sciences. Whilst the word is often used in the education literature, there is little evidence of an adequate response by researchers and education managers to the importance of stakeholder analysis.
- **This is more than just teaching and learning:** Managing ICTs in education demands attention to issues of culture, a recognition of the importance of people, and attention to the sociology and socio-economic conditions that prevail.
- **The business of education is complex:** Superimpose the management of ICTs on the many other complexities at hand and we have a serious challenge to deal with. Managing complexity may be one of the critical competencies that we need to make the best of our opportunities.
- **ICTs can impose high levels of change**: Depending on a focus on simple efficiency , or higher levels of educational effectiveness (not the same thing) the degree of change involved varies and education management needs to respond accordingly.
- **A present example is "learning analytics":** Shall we **measure** how quickly learners type their work? Monitor how long they have been working on a document? Analyse all the searches that they did on the Internet? Build graphs of who they talk to, and for how long? As we move forwards, we will be increasingly tempted to measure everything, at ever-increasing levels of detail.

Summary of the bibliography findings

For the project team, the issue of ***managing differences*** became pre-eminent, because it embodies the need to deal with different contexts, capabilities, competencies and attitudes and cautions us about over-simplification of a complex situation. Existing research into the management of technology in South African education – such as it is – needs to be tempered and located properly in a complex space, that accommodates education at different levels (primary, secondary, tertiary and elsewhere), in different places (for example rural and urban), with different cultures (wealthy and poor), and with different objectives (efficiency, effectiveness or evolutionary). It is a traditional problem with information technology and systems that the "user space" is often seen far too simplistically, with inadequate attention to the subtle differences that will make or break the implementation of new systems. One way of dealing with this is to invoke existing stakeholder analysis and stakeholder management techniques that are well-established elsewhere. But more of our recommendations later.

Looking to the future, it is clear from the literature review that education is already an *international* business, that technology is extending and consolidating the internationalisation of education, and if South Africa cannot match the efforts and achievements of other countries (against which we must be continuously benchmarked) then our future educational prospects are bleak. The differences in the capability of undergraduates coming from overseas, compared with those from South Africa, reveals the importance of acknowledging the need to work to international benchmarks. Understanding the potential for our educational systems in a competitive international context, and understanding all stakeholders' needs and expectations, will be considerably assisted by the availability of an effective reference model.

The reference model

The idea of a "reference model" to help manage complex situations has quite a long history that we do not need to be concerned with here, but the idea has become associated in modern times with the rise of *systems* and *systems thinking* and it contributes to dealing with complexity. Any systematic examination of society (or business, or government, or education) will undoubtedly conclude that these domains of human activity are indeed complex.

People in management roles generally deal with complexity by means of "abstraction". They take a simplified but well-organised view of a complex domain in order to render it understandable and manageable. This idea, which in its simplest form can be referred to as "reductionism", can be traced back to the work of French philosopher Descartes in the 17th century, but more recently it has become a feature of *ontological thinking*; this way of thinking considers that any reality that we wish to understand can be seen as (or is actually composed of) *a set of entities that are related*. All we have to do (it might be said) is to find and agree them.

The final form of the reference model

The full reference model, as it emerged after a considerable period of reflection, discussion and debate, is shown on the following page. Some explanatory notes follow, and there is a fuller explanation about the derivation of the model in the appendices.

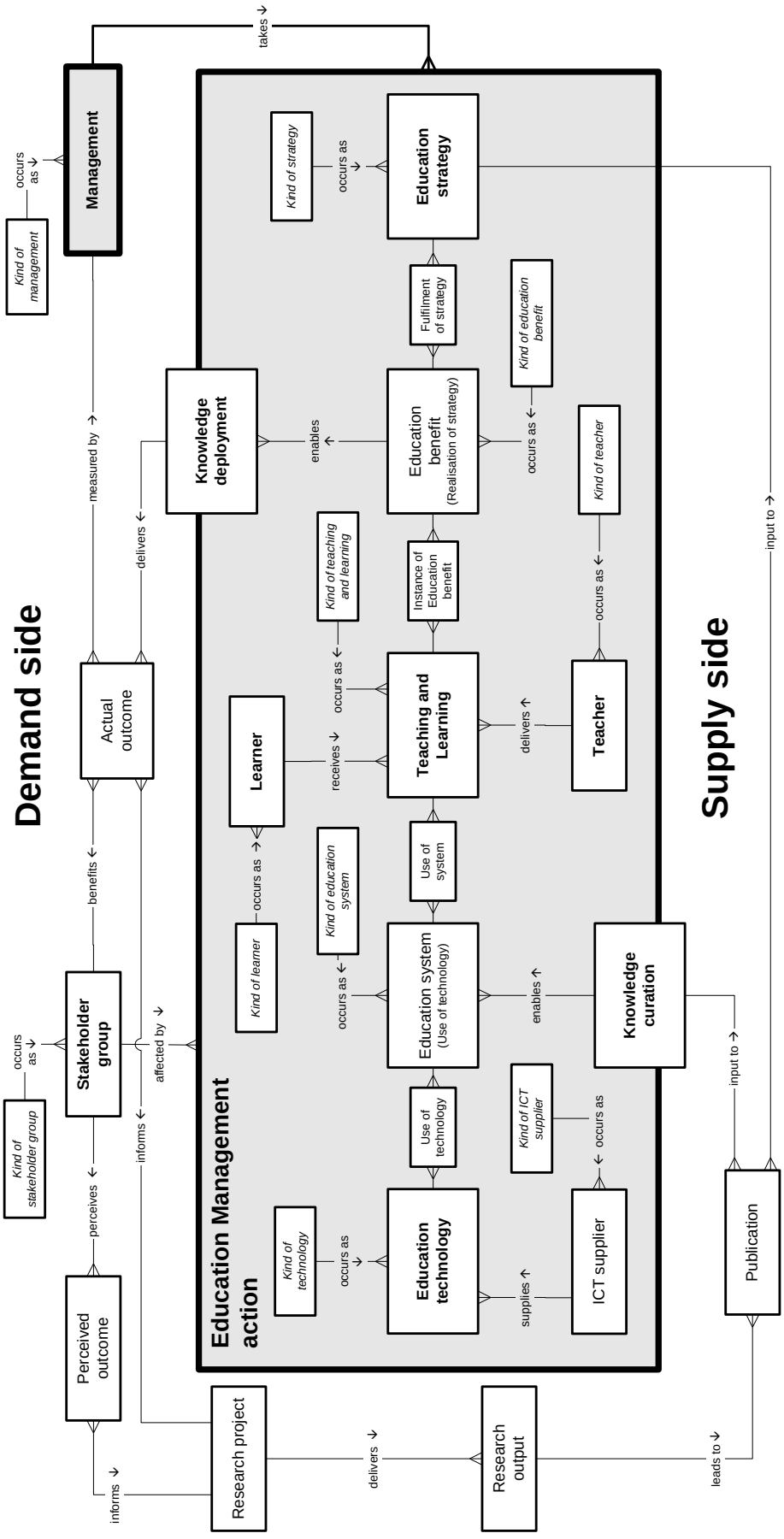

Figure 3: The final form of the reference model

Notes about the reference model

- The model introduces the idea that there is **management**, and there is **management action**. Management action embodies most of what we are interested in here.
- Fundamental to education is the idea that there is knowledge that must be imparted so as to capacitate learners to progress academically and, ultimately, to make a useful contribution to the needs of society, and business, and government. The model shows **knowledge deployment** and **knowledge curation** in order to make this clear. The choice of the word "curation" is tentative at this stage, but it is a word that has grown in common use recently and it is conveniently open so as to embrace all forms of gathering, growing, organizing and making information available for education.
- There is a "**demand**" side and a "**supply**" side but generally the servicing of demand by means of supply works from the left to the right.
- There are two views of this model: from the supply side it really all begins with **education technology** and ends (somewhat distantly) with **education strategy**; for the demand side it all begins with **education strategy** and ends (again, somewhat distantly) with **education technology**. In this way we can begin to see how the perceptions of education management can be reconciled with the perceptions of technology enthusiasts.
- **Education technology** and **education strategy** have three important entities between them so that all five taken together comprise a "chain of value", showing how an investment in technology might be judged to be useful in meeting strategic needs:
    - **Education technology** (… is used in an …)
    - **Education system** (… that supports …)
    - Teaching and learning (… that delivers …)
    - **Education benefit** (… that fulfils …)
    - **Education strategy** (… that hopefully meets the national purpose.

  We started with **education system**, **teaching and learning**, and **education strategy**; the introduction of **education system** and **education benefit** are critical moves to deal with many-to-many relationships, and to reveal two fundamentally important features of a complete management regime: without an understanding of the systems we are using, and the benefits we are seeking, there will be no possibility of a complete and coherent view with which (or from which) to manage effectively.

- Then, multiplicity at each of the four junctions of these five important entities is resolved with four associative entities, as explained above. These are the four points where performance data might be captured (or perceptions elicited) in order to inform decisions about information technology and information systems investments, and to evaluate the outcome of an investment of time, money and effort at each stage.
- **Teachers** and **Learners** are central to the model, but other important role players include **ICT suppliers** and other **stakeholders**; further development of the model could incorporate and show other specific stakeholder groups, but at this stage only **ICT suppliers** are shown.
- In order to deal with the issue of *differences* (in teachers, and learners and contexts) it is necessary to introduce five typologies:
    - Kind of management
    - Kind of technology
    - Kind of teacher
    - Kind of learner
    - Kind of strategy.
- Finally, it would not be a complete model about education if research and publication were not included. By understanding the **real-world outcome**, through careful research (whether "academic research" or simply "policy reviews"), and by promulgation of the **outputs** of **research projects** through **publication**, it is possible to extend our collective knowledge and

maintain an active and progressive curation of knowledge for the benefit of education. This the virtuous circle that augments and improves education, and delivers ever-improving outcomes for the benefit of all.

The appendices provide a much more fully worked explanation of how the final form of the reference model was developed and cross references to the sources that were used.

Benefits of the reference model

Management actions are seen as concerned with a range of issues, principally the five stages in managing the value of information technologies in education: understand and acquire the technologies that are needed for the education systems that will make appropriate contributions to teaching and learning, which will deliver education benefits that serve the aims and objectives of education strategy. But it is complex, and the model shows how specific instances of the use of technology and the use of systems deliver specific benefits that make specific contributions to fulfilment of strategy.

The positioning of the teacher and learner, adjacent to teaching and learning, requires that their use of technology and their contribution to strategy are seen only through the systems that they use and the benefits that they enjoy. Equally, the positioning of knowledge curation and knowledge deployment remind us that the flow of knowledge into and out of the education system is what moves everything (and everyone) forwards.

Outside the domain of management actions we have stakeholders, with ICT suppliers, the "real world" and researchers highlighted, but no restrictions on other stakeholder groups that could be incorporated because the model shows how we can begin to get a grip on the differences that we identified early in the project (at the meeting of experts) that were the first signs of the complexities that managers must deal with; these differences are to be found in teachers, learners, technologies, strategies, managers and stakeholders. Other typologies (such as for suppliers, and systems, and benefits) can easily be added if needed because of particular management or research needs.

The model gives substance to the idea that there is a virtuous circle of educational activity, whereby research can examine the results of education and the needs of the real world, and publish the kind of knowledge-based learning resources that education needs.

Finally, and perhaps most importantly because we are concerned with managing change, the model provides a framework for measuring the before-and-after condition of an education institution that tracks the consequences of management actions.

Ancillary achievements of the study

Activities from the meeting of experts

Proposal for a special issue of a journal

At the meeting of experts it was agreed to make proposals for a special issue of a journal of education, that would invite papers about managing technology in education, so as to bring together current knowledge and provide a platform for experts to discuss and develop their ideas. At the time of writing this proposal has been submitted and is "in process".

A Flash MOOC

At the same meeting, it was proposed to launch a "Flash MOOC", to combine the idea of a Massive Open Online Course with the idea of a Flash Meeting – a spontaneous gathering of people, organised through text messaging and the social web, but in this case with prepared material and an opportunity to chat online with study leaders. This event took place in October 2013 and has been analysed for its outcome and its content. It is reviewed in detail in Appendix 3.

Other related activities

It is not possible to establish and execute a three-year research project without some unexpected and related opportunities emerging that parallel the work of the main project, but are actually run separately. In this case, there were three other activities that are worthy of mention.

An open source Qualitative Content Analyser for researchers

Dealing with the large volume of bibliographic literature demanded that some kind of systems-support was put in place to manage the allocation of responsibilities for reading and reporting, and the analysis of the content of the literature. Excel was used for the former, but the opportunity was taken to further develop a database that was already in development, for the organisation, management and analysis of qualitative research data. This work has already been reported in a peer reviewed journal (Bytheway, 2013a) and is still progressing. Further information can be found at the project web site: http://qualanal.wikispaces.com.

A new academic book on Information Management

For ten years, a free-to-download text has been available that was a main deliverable of a research partnership (between CPUT and UWC) funded by the Carnegie Corporation of New York: "The Information Management Body of Knowledge" (IMBOK). Stimulated by the project reported here, and in order to make the work relevant and available through normal channels, the text has been completely revised and is to be published imminently by Springer in Geneva. The new book includes some illustrative material about managing information in education that is drawn from the present project.

Academic papers

As already noted, there is one early paper that has discussed the use of technology in education, for qualitative research data management (Bytheway, 2013a). More recently, a paper has been published that discusses aspects of technology in training pre-service teachers (Sabiescu et al., 2013). A further paper has summarised the results of eight international interviews that examined education management practices concerning information technology in different countries (Bytheway & Venter, 2014). The data reported there is from 2011 and established some baseline ideas for the project reported here.

The Chronology provided in the appendices indicates a number of other occasions when the team presented at conferences. A plan for further publications is in place.

Personal research

Each of the three members of the core team – Andy Bytheway, Moira Bladergroen and Laban Bagui – are not only actively researching in their personal capacities, they are moving forwards in directions that have been enabled and set by our joint experiences on the project reported here.

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Appendix 1: The bibliography

There is a large body of literature dealing with education, and equally there are extensive collections of work dealing with management and technology. The challenge on this occasion was to find literature that touched on each of these three domains and this was done in a progressive way.

The review is organised as explained below. There is a summary of the findings of the review at the end

General comments

It proved difficult to find a representative volume of recent material from South Africa, but looking back ten or more years provides some insight into the emergence of research and it reveals the trajectory of academic work in this area that has been being published. Further, as it is clear that globally education is becoming more and more of an international phenomenon, in this review fairly liberal use is made of international work.

Organisation of the search and the outcome

First, a simple keyword search identified more than 700 papers that were reasonably recent, concerned with one or more of the target domains, and accessible.

This "long list" was reviewed by the team and about 180 papers (listed in the bibliography at the end of this report) were chosen for more careful study. Key sections of these papers were selected (as indicative of important issues) and annotated. The narrative that follows includes illustrative sections within the discussion, under the three main headings addressed by the project:

- **Education**: strategic and contextual issues in education that require management, especially because of information technology opportunities or dependencies.
- **Technology**: particular technologies that are seen as a driving force in educational change.
- **Management**: the practice of management in education, especially in relation to the adoption and implementation of information technology.

However, what also came out of the review is that there are three related and important areas of concern: the **implementation** of changes that are related to educational information technology and information systems, dealing with the **consequences** of those changes, and understanding the best approach to the **academic research** that is needed.

There are therefore six main sections following:

- Education
- Technology
- Management
- Implementation
- Consequences
- Research notes

International distribution of articles

The distribution of subject matter across the discovered articles was roughly equal across each of these three main headings, and a main focus was the country of origin, to ensure that South Africa was fairly represented. The actual count across countries was as follows:

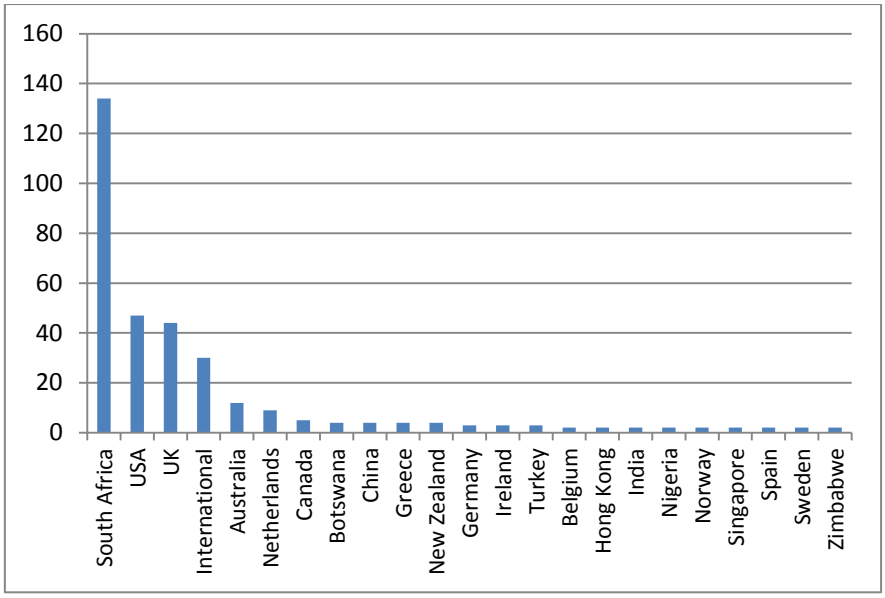


Figure 4: Distribution of selected articles by country

This kind of research tends to be very international and it is worth trying to apply a degree of international thinking in all cases so that lessons can be learned and results can be shared. Wolhuter notes that:

> *"28% of Education research that is done in South Africa and published in journals, was published in international journals … It would also be valuable to do research to investigate how international literature and scholars are presenting South African educational issues , in order to identify opportunities to link with the international scholarly discourse." (Wolhuter 2011:612)*

The main sections that follow now discuss South African and International work, based on the content of the selected articles and on indicative extracts taken from them. The selections are constrained by the space available in this report (and by the time available to the reader to read them) and they are hardly a *complete* treatment, but they are sufficient to bring out some of the issues that seem to be important to South African education at this time, from which we can build a more considered managerial view of what must be done and how it might be done.

Education

Things are changing in education

The introduction of information technology into education engenders change at all levels: in schools, in universities and in other forms of further education. In all situations where there is change there needs to be a *strategy* to deal with it, and much of what follows here is really concerned with the strategic issues that are present in the management of education and its adoption of information technology.

The discussion that follows here will step lightly into the literature on primary, secondary and tertiary education in order to bring out common themes that have general importance. But we can start with information technology and systems in secondary schools – perhaps the most common subject of research and analysis.

Early international opinion argued that our expectations of information technology in schools were already long-outdated, and different approaches and ideas needed to develop around the use and integration of ICT in Schools:

> *"ICT in Education has become big business and yet we still have not come to an exact understanding of just where this fits with the curriculum currently being delivered in schools. In*

> *addition, we have yet to refine and better define not only how schools and computers should go together, but what their impact will have on the nature of learning and the quality of the students who graduate from schools of all kinds." (Ortega & Bravo 2002:2)*

This makes clear the extent and depth of the challenges that are faced. Other international research found (still some time ago) that relatively little progress had been made:

> *"A small percentage of schools in some countries have embedded ICT into the curriculum, and demonstrate high levels of effective and appropriate ICT use to support and transform teaching and learning across a wide range of subject areas. Most schools in most countries, however, are in the early phase of ICT adoption, characterised by patchy uncoordinated provision and use, some enhancement of the learning process, some development of e-learning, but no profound improvements in learning and teaching. Such progress has been achieved at considerable cost. All EU countries have invested in ICT in schools: equipment, connectivity, professional development and digital learning content. What does the research and evaluation tell us about the return on investment in ICT?" (Balanskat et al 2006:3)*

Quite so – that is exactly what this review is intended to establish: what are the available "returns" on investments in educational technology, and are they evident in South Africa? But before we move on, one more UK review has important implications based on fundamental changes that are just around the corner, and it affirms that there is a role for research to play:

> *"National curricula need to embrace the fact that knowledge can be represented in new forms and this will have a fundamental impact on how a subject/topic is presented, taught and assessed. This, in turn requires professional development for all those in designing and creating national and local curricula and examinations. Finally, new research projects need to account for the limitations of previous research methods discussed in this paper so that research outcomes are more generalizable, can be useful to many different countries and cultures and provide a robust and reliable taxonomy of the relationship between different ICT resources, teachers' pedagogies and students' learning. This will enable governments to identify more effectively the cost benefits of ICT in their education budgets and more securely plan and implement new innovation programmes involving ICT in education." (Cox and Marshall 2007:68)*

Hence the need for research is ongoing and it is not just about education, or technology: the management of cultural issues proves to be a key factor in achieving useful results from information technology investments, in Canadian universities as well as elsewhere in the world:

> *"… further research in the area of ascertaining the cultural factors that contribute to adoption of technologies is necessary; and more importantly, beyond seduction and disenchantment the contestations offer a deeper understanding of academic culture and its role in the implementation of technologies in higher education." (Ferreira 2010:25)*

Education is complex and extends not only from primary to tertiary (or from pre-primary to adult), it is seen differently in different sectors of human endeavour. In specific sectors of education there is evidence of the different importances of information technology. For example, in the health sector:

> *"The traditional models of learning are being replaced by the emergence of new advanced technologies that provide the facilitators with an exceptional opportunity, creating blended learning environments that are highly interactive, meaningful and learner-centred. [This] is a movement within health professions education that allows professionals to identify, disseminate and promote the adoption of practices based on research" (Frantz et al 2011:17)*

Tightening the connections between research and learning in all sectors sounds like a great idea, especially when the pace of change is so great. And the potential to improve the availability and delivery of health services is hugely important at the present time, but we must be careful not to assume that one-size-fits-all. The issue of "differences" became a recurrent theme in our reading of the literature.

Different strokes for different folks

The extent of the non-technical and non-educational issues that must be managed will become clearer as this review proceeds. In South Africa, the divide between rich and poor is a constant feature of life and a deeply difficult issue to deal with. Government developed policies that tried to set out a way forwards, but within a few years it was clear that all is not well:

> *"… it is apparent that the policy's implementation plan is optimistic given the progress to date with 68% of schools nationally having no access to computers for teaching and learning (Department of Education 2007). It would appear that the stated timelines will have to be revised or alternatively the implementation accelerated to achieve the plan's goals. Only two out of nine provinces are currently committed to implement ICT into the classrooms and have the necessary policies and strategies in place to do this and these being the wealthiest provinces, this does not bode well for the intra-country digital divide mentioned earlier." (Howie & Blignaut 2009:361)*

Howie and Blignaut found stark differences between provinces:

> *"Schools in Gauteng, probably the wealthiest province in South Africa, have access to computers for learning in 67% of schools but only 48% of those have fewer than 100 learners per computer. In contrast schools in Limpopo, one of the poorest provinces, have learner access to computers in 18% of its schools and only 10% of the schools in Limpopo have less than 100 learners per computer (Department of Education 2007). Clearly the strategies for the less well-resourced provinces will have to be addressed differently if the country as a whole is to succeed." (Howie and Blignaut 2009:361)*

Clearly, it is critical to manage different situations differently, and managing change is largely a matter of managing the different kinds of people who are affected, just as much in South Africa as elsewhere. In the higher education context:

> *"… a one-size-fits-all strategy for building a learning organisation is unlikely to be successful. It is nonetheless critical that eLearning be seen as part of the normal, traditional teaching-and-learning environment of the institution" (Stoltenkamp and Kasuto 2009:53)*

More recent work in the Western Cape has found that the successful implementation of information technology is as much to do with *perceptions* as it is to do with *actuality*. A study of teachers working in primary schools in poor areas of the Cape Town metro revealed that on the surface they are positive about information technology, possibly because they fear being seen as backward-looking, but implementation had proved to be very problematic because of anxiety about capability:

> *"The study noted that the educators' discourses on ICT s in education were supporting the dominant discourse from the macro level, i.e. the use of ICT s in education only has positive effects. This is in direct contrast to the numerous challenges (all relating back to management) facing educator s in their context and, the (consequent) low rate of uptake of the technology … Educators' perceptions of technology in education are somewhat shaped by technological determinism and imperialism – the perception that resisting technology is equivalent to being backward)" (Bytheway et al 2012:116)*

Hence, we learn that it is important to understand the *perceptions* of teachers and to manage their *anxieties*. It is a long time since education specialists first realised that there is more to the successful adoption of information technology than the nuts and bolts: the *sociology* of educational technology has been identified as an ill-informed area that must be better understood:

> *"There was a kind of mechanistic enthusiasm … if we could just find the right approach, the thinking seemed to go, we could address the problems of schooling and improve education immensely. The world of the student, the classroom, the school was, in this interpretation, a machine (perhaps a computer), needing only the right program to run smoothly …" (Kerr 1996:144)*

This mechanistic enthusiasm can still be seen in South Africa today, but – as we have noted above – in South Africa we find repeatedly that economic difficulty really gets in the way: socio-economic conditions are real impediments to the adoption of ICTs by disadvantaged schools.

> *"The study shows that despite the willingness of the educators in the schools operating in the disadvantaged areas to integrate ICTs in their teaching and learning process, the economic situation of their schools and communities make it difficult for the teachers to achieve those goals. Unlike the schools in affluent areas that are able to raise funds from parents, schools in disadvantaged communities are not capable of raising their own resources. In such [a] situation, providing physical infrastructure without provision of resources to sustain the technology would most likely result in sub-optimal use of the technology." (Chigona et al 2010:30)*

This is a theme that is very familiar to anyone involved in South African education, of course, but it needs to be repeatedly stated, and it needs to be addressed. One way of doing this, with some risk, is to encourage a mood of *entrepreneurialism* in schools:

> *"The three schools also indicate an entrepreneurial orientation in that their focus is not only on acquiring resources, but also exploiting opportunities that attract resources ... Clearly, ventures undertaken at these schools were not without risk taking ." (Xaba & Malindi 2010:11)*

Frustratingly, however, this South African study by Xaba and Malindi was not specific to information technology, it was a more generalised study of entrepreneurialism in schools. Nevertheless, their findings are applicable to the management and use of information technology as just another resource that is useful to have in school, as well as other more traditional things. The review repeatedly found that education research concerned with resource management, skill levels, pedagogy and governance consistently ignores the availability and potential contribution of educational information technology and systems. This needs to change.

Getting a grip on things

Laura Czerniewicz has been studying the specific issues of information technology in higher education for many years now, and early in the history of technology in higher education she had very clear views about what was needed, drawing on the wider literature as well as on her own research:

> *"Access involves developing techno-literate practices, which Lankshear et al (2000) describe as having three dimensions: (1) an operational dimension (use and operate technology and its associate language systems); (2) a cultural dimension (use the technology appropriate in real world contexts); and (3) a critical dimension (evaluate, assess and critique the technology and all it provides) ... Because the digital domain has become so dominant and is changing how the world works, it is creating new realms of exclusion for students without access to computers and lecturers who are grounded in the pre-digital print culture. In a context of accelerating inequalities, it adds another layer of complexity to the challenge of social inclusion." (Czerniewicz 2004:149)*

Once again *culture* emerges as an issue, and the need to be able to measure and manage the *consequences* of information technology and systems in education – an important issue to which we will return. Czerniewicz cautioned us that at this early stage national policies and plans were *not being followed* and that there was more to the problem that just *access*:

> *"Currently, academic staff engagement with educational technologies in South Africa is not steered by either national or institutional polices ... Access to technology does not in itself ensure access to equal educational opportunity ." (Czerniewicz 2004:150)*

Even today, 10 years later, it is not yet clear that national policies and plans are helping, and issues of access have changed dramatically with the availability of cell phones and tablets just at the time that some administrations had concluded the implementation of PC-based “ICT Laboratories” in schools.

There were other issues emerging concerned with the sheer complexities of the education system:

> *"It is also evident from participant narratives that computer-integrated education projects are implemented in an educational system which is, in turn, embedded in larger systems. The dynamism of these larger systems thus also influences the educational system, and, by extension, the projects implemented in that system. Such influences, drawn from nested systems cannot be viewed as discreet, individual forces, but rather as interrelated, co-determinants of sustainability." (Thomas and Cronje 2007:776)*

However, practical steps have been taken to assist, for example in providing well-considered advice to school principals. Bialobrzeska and Cohen have developed a complete guide to what must be done by school principals in South Africa:

> *"One of the central messages running throughout this guide has been the idea that what you can do with ICT depends on the resources available and the vision you are working towards. This message holds equally true when it comes to using ICT as a tool for learning and teaching. The degree of ICT integration into the curriculum depends on the level of ICT provision as well as the capacity of your teachers … "(Bialobrzeska and Cohen 2005:96)*

And they wrap things up with some observations about the changes that have occurred:

> *Since the introduction of an outcomes-based approach to education in South Africa, there have been significant shifts in our pedagogic approach. These include the following:*
>
> - *A shift from authoritarian approaches which encourage rote learning, to teaching in which learners are encouraged to question and use their own prior experience and knowledge - to think critically, to reason, to reflect and to take action;*
> - *A shift from transmission or teacher centred mode to approaches in which the teacher mediates learning and helps learners learn for themselves - learners shift from passive to active learners;*
> - *A shift from a single authoritative textbook to the use of a range of resources;*
> - *A shift from summative, examination-focused assessment to a continuous, formative approach to assessment;*
> - *A shift from individualistic to collaborative learning approaches."*
>
> *(Bialobrzeska and Cohen 2005:97)*

It is surprising that this immensely useful work by Bialobrzeska and Cohen has only received 20 citations since publication[5], and it is equally surprising that major studies of information technology in education at this time did not pay particular attention to the *management* of ICT in education, despite the fact that the internet itself provides a convenient means to access survey data:

> *"Collecting large amounts of data in international surveys over the internet offers substantial cost and time benefits. However, these advantages do not provide enough grounds to implement online questionnaires unless one can prove quality in terms of high participation rates and comparable data. SITES 2006 provided an opportunity for the IEA to explore the feasibility of collecting data over the internet in addition to the traditional paper-and-pencil questionnaires." (Blignaut et al 2010:568)*

Surveys are one thing, practical guidelines are another, it seems; it is more of *the latter* that we need, right now.

People can make a difference

The SITES ("Second International Technology in Education Study") survey quoted above, reported by Blignaut *et al* (2010), was a large international investigation of the pedagogical use of technology in schools. However, the significance of the results is lost in the numbers (which seemed to show that the situation in South Africa was close to hopeless). We will return later in this review to the question of how this kind of research is best done, but at this stage we can simply observe that

[5] According to Google Scholar, at the time of writing

stories about single individual initiatives to "do something about it" brings the situation to life, such as we see in the management guidelines for school principals made available by Bialobrzeska and Cohen.

Another story, from university education, makes a similar point and highlights the potential role of the individual:

> *"When I began to see the potential benefit of the World Wide Web to education in 1994, after watching technologies come and go for many years, I started experimenting with the technology. By 1995 I had established a web server in my academic department (Botany) and had begun to create and mirror content for use in my courses. This was at a time when the Information Technology Department saw its role as supporting the administration, and it had to be coerced into supporting even email for academics by some activist academics in the Physics and Botany Departments who set up their own email servers." (Keats 2009:50)*

This is an interesting tale from the very early days of information technology in education, when understanding of its real potential was very limited. The majority of teachers caught up with Keats' trail blazing in due course, and more than 10 years later:

> *"The advance in technology across the world has had a revolutionary effect on knowledge production, dissemination and use. Universities have had to adapt to the knowledge revolution by creating more access to ICT. Lecturers in the study would like to have modern ICT devices in their classrooms. Some of these include computers (internet) with projectors, televisions, DVD players, assimilated experiments using technology and tutorials on a Web page for immediate assessment. ICT can be used to enhance learning and create varied learning experiences." (Singh 2008:1063)*

Whether this is actually true for *all* lecturers, and whether we actually understand *all* the issues at an institutional level, is still to be established. One thing we have learned since the early days is that there are other people, outside our institutions, who are able to impact on our efforts to bring information technology into education: we can refer to them as the external "stakeholders" who can make or break our efforts to succeed.

Other stakeholders are important

In schools, the relationship between parents and teachers has been a subject of study for many years.

> *"Parent capital, such as cultural knowledge , experience in raising a particular child and parenting experience and skills, is not easily recognised by teachers … parents have been socialised into the rituals of parent-teacher conferences by school protocol, their own experience when learners and historical knowledge about parent-teacher conferences … schools should regularly appraise the effectiveness of their parent-teacher conferences by obtaining parent and learner opinions on their practices ... schools should use a variety of communication strategies which focus on the communication of positive feedback to parents to cater for families where children are performing satisfactorily" (Lemmer 2012:94)*

This work by Lemmer is an interesting qualitative analysis of the relationship between South African schools and parents, but apart from brief mentions of email and SMS as a means of invitation to meetings, the work fails to recognise the potential of the social web and the *shift in the balance of power* between stakeholders as information becomes more and more a public property. Perhaps this is just another case of the real world moving forward more quickly than academic research, which struggles to keep up with it. One could develop quite a long list of other stakeholders (employers, regulators, policy makers, service providers and local communities, to mention just a few) but *teachers* and *learners* are pre-eminent in any list, of course; research reveals some interesting facts about the role of the child at school, for example in evaluating the contribution of information technology. Downes has examined this aspect of the learner as a stakeholder:

> *"Some issues become more salient because the child has been accorded the role of stakeholder. For example, whose permission should be sought to include children as stakeholders? In law children are not able to give consent and sign contracts. Parents and guardians carry the legal responsibility until a defined age. General practice in educational research and evaluation in school settings is to seek written consent for access to children from a hierarchy of groups which usually begin with school systems, school principals and parents. Usually it is only after these groups have agreed that individual children or groups of children are approached. If children are to be accorded similar rights to adult stakeholders, should their consent be the first sought?" (Downes 1999:336)*

Perhaps some people in positions of educational authority would have great difficulty in accepting this as a norm, but as we all become more and more used to using web services such as TripAdvisor.com to make our travel plans, we must anticipate the day when learners and others will routinely make use of web services such as "SchoolAdvisor.com" and "UniversityAdvisor.com" (the former already exists, the latter is one of those domains that has been registered and is now available "for sale" – but there are many active sites with less obvious domain names that are, no doubt, developing rapidly).

The importance of the learner as a stakeholder has also been revealed in a case where learners actually taught the teachers (about information technology) – they became known as the "Computer Trustees":

> *"But no changes had taken place yet in the usual pedagogical practices at school, and the computer trustees still had to fulfill, in addition, their traditional roles as learners." (Tubin et al 2003:134)*

This case was reported in Israel, and therefore it might not be comparable to the typical school in South Africa. On the other hand, is it so surprising to suggest that our learners could take responsibility for teaching the teachers, in South Africa? It is clear that the limitations constraining the adoption of information technology and systems are primarily resource-based, and learners are a potential resource that is already extensively tapped in universities (to run computer labs, provide hands-on support to other learners, and so on) so why not in schools?

Establishing exactly who the stakeholders are in an educational environment, and what their needs and expectations are, has been the subject of research using a "systems analysis" method:

> *"Soft System Methodology … derives [a] Model of Stakeholder Requirements … a model was developed to represent the stakeholders' evaluation criteria mind map [that] allows the information to be laid out in an easy to understand format for the project management and stakeholders of the MLE [Managed Learning Environment]." (Hardman & Paucar-Caceres 2010:180)*

Managed learning environments are said by Hardman and Paucar-Caceres to be common in the United Kingdom, but they add that there is no generally accepted single definition of what they are. However, the application of a proven systems analysis method in order to establish stakeholder needs sounds to be extremely useful. It brings some kind of discipline to a critical process that easily gets into trouble when it is inappropriately managed and executed – the analysis of *needs*.

Other forces for change

As major South African businesses expand within the continent of Africa and internationally, and as international businesses continue to show an interest in operating in South Africa, it is worth remembering that we cannot educate alone in a South African "bubble", and that South African educational institutions face increasing competitive pressure from international sources:

> *"Drawing on a diverse body of academic literature including insights from international business, knowledge management and education theory, we affirmed the importance of foreign assignments for the implementation of universities' international business development*

> *strategies, international educational delivery and the creation of an environment in which knowledge resources can be effectively utilized on an international basis." (Boyle et al 2012:312)*

That might be seen as the "big picture". Schools are perhaps less interested in internationalisation, and within countries such as Hong Kong, where the adoption of information technology in life generally is greatly advanced, it is acknowledged that there are many other variables in schools:

> *"… ICT is able to act as a lever to bring about perceived changes in student learning in the context of establishing collegiality to foster pedagogical innovations in schools. In this study, variables like "school climate" and "ICT implementation strategies" captured the concept of collegiality, and they were shown to have a significant impact on perceived changes in student learning. These further supported the proposition that the benefits of ICT cannot be adequately separated from other variables that impact learning in the larger instructional context." (Wong and Li 2008:114)*

Today, the education that is available in Hong Kong schools is of little interest to learners in South Africa, although one recent conversational anecdote reveals that at least one South African is learning computer programming having registered on two different courses, one at Harvard University in the USA and one in Hong Kong. How soon will it be before home-learning in South Africa, with an international syllabus and international sources of material, really takes off? Of course, it is already happening in families that can afford it, because of the poor quality of school education in South Africa. This further exacerbates the divide between the haves and the have-nots.

Implementation

It is a well-worn truism that strategy *formulation* can be fun, but strategy *implementation* can be a nightmare. Different experts have different ways of breaking the problem down.

Czerniewicz points out that implementation can be set at different levels: simple improvement, innovation, or transformation:

> *"Three clusters of meanings of the relation of technology to higher education change emerge in this empirical research: first, ICT and higher education change as improvement, second, ICT and higher education change as innovation, while the third locates ICT change in, and as, transformation (in different ways)." (Czerniewicz et al 2006:8)*

This three-level view of change is well established in the literature of information systems management and it is good to see that it has been applied here because the managerial differences between improvement, innovation and transformation are highly significant. Implementation con currently at different levels is a recipe for confusion; setting targets within a single level is much more practical. Philip Uys has a model for transformation based on work in Botswana, New Zealand and South Africa:

> *"The LASO (Leadership, Academic & Student Ownership and Readiness) model for Technological Transformation in Higher Education emphasises the necessity for integrated and orchestrated top-down, bottom-up and inside-out strategies." (Uys 2007:251)*

As is implied here, Uys's way of working combines working from all directions in order to gain coherency, but some of this work is now old. At about the same time, in her introduction to a collection of related papers, Deryn Watson picks on the high level view:

> *"In our field we have three interlocking areas of change interacting together — technology itself, education, and society. I would maintain that using theories and models of innovation and change will help us ground our new empirical work within a perspective that acknowledges the complexity of both the nature of innovation and the change process, and which allows a reflection upon the reality in context." (Watson 2006:214)*

Here we find more encouragement to deploy established management techniques to deal with information technology in education. At a more practical level of implementation, the nation requires that new teachers are motivated, properly educated and trained, and ready for the new

digital age of education. There is research that attempts to understand the motivation of young people to become teachers, but yet again it fails to address any of the factors that arise from new educational technologies:

> *"The need for an inspired professional teacher corps to haul South African school education out of its current low level of quality was the driving force behind this project. Its aim was to determine what counted as sources of inspiration for student teachers and hence for future teachers ... from most to least important: (extended) family, religion, the teacher education institution, teaching practice, friends, and personal life. A comparison with similar research elsewhere revealed that, in this sample of respondents, considerations, such as education being the only accessible profession or being forced to enter the teaching profession because of economic circumstances, did not figure at all." (Wolhuter et al 2012:178)*

Research like this is cutting right to the heart of the matter – the very reasons why people are interested and motivated to become teachers.

> *"In many ways innovation and change can be classified by two distinct approaches — identify a problem and the structural changes needed to solve the problem, or focus on the people in organisations involved as sentient, dynamic systems. It is clear that in education the human dimension is critical" (Watson 2006:214)*

Yes, the human dimension is important, but we cannot ignore the fundamental changes that are at hand that arise from educational information technology and systems. Wasko brings this into some focus and helps us to acknowledge the eras of the world wide web:

> *"As the Internet develops from web 1.0, enabling us to connect "to" the Internet, to web 2.0, where we connect "through" the Internet, to web 3.0, where individuals connect "within" the Internet, many researchers and practitioners are questioning how this development might impact society and the organization of economic activity. Many talk of the new generations entering the workforce, the "digital natives"—those who have grown up never knowing life without a computer, the Internet, a mobile phone, or virtual worlds. They are challenging many of the basic assumptions we have held since the time of the first industrial revolution regarding the firm, employment, and work, and are developing new forms of organizing economic activity." (Wasko et al 2011:652)*

Quite so. Things really are going to change and implementation will be challenging. We are reminded (as we were earlier) that there are different kinds of people, and that it is the perceptions and attitudes of those different kinds of people, above all else, that we will have to manage as we embark upon change. This review will return to issues of implementation later.

Technology

The emergence of specific technologies

Technology is a feature of many of the discovered papers, but its treatment was typically driven by *specific* technologies that were new, or emerging, at the time of the work.

For example, whiteboards and smart pens were emerging about nine or ten years ago:

> *"The findings reveal that although the types of interactive whiteboard systems have slightly different benefits and drawbacks, the critical issues seem not lie in the choice of the type of interactive whiteboard technology per se, but rather in the way in which they are deployed in previously disadvantaged schools. The key issue seems to relate to teachers' prerequisite ICT literacy and integration skills that need to be in place prior to the installation of interactive whiteboard technology. It would seem that unless teachers are sufficiently ICT literate and the school is in a position to support the use of interactive whiteboard technology, the interactive whiteboards are not used optimally or in a sound pedagogical manner in the classroom." (Slay et al 2008:1330)*

This is not unimportant, but it is fairly mundane stuff when we realise that each year there is a new kind of presentation technology, and what staff really need is the confidence to take on new technologies *without* special training and support. Slay and her colleagues talk about integration skills and pedagogy, but it is the latter that is more important. However, many aspects of learning design are being taken out of the teachers' hands in that one can rely more and more on *digital* media in ways that bring learning more within the control of the learner. Video sources on the web are now commonly used to inform and teach a vast range of skills, for example: computer programming, car maintenance, and even bizarre things like forming a young child's go-to-school ponytail in a few seconds, with a vacuum cleaner[6].

In his discussion of the YouTube and Google generation, Duffy refers to this as a "shift from Push to Pull":

> *"In part this shift from 'Push' to 'Pull' can be seen to relate to George Siemens's (2005) notion of Connectivism. Paraphrasing, he indicates that we derive our competence from forming connections.... unlike constructivism, which states that learners attempt to foster understanding by meaning-making tasks, this theory indicates that the meaning exists and the learner's challenge is to recognize the patterns which appear to be hidden. Meaning-making is seen to involve forming connections between specialized communities and information / knowledge architectures." (Duffy 2007:182)*

From vacuum cleaners and ponytails to Connectivism, in two paragraphs – such is the range of issues that education has to deal with! At the heart of it all, it is raw technology that drives much of the change that we face today.

Technology drives change but needs to be understood

Although the connectivist idea is a novel one, Duffy is absolutely right to point out that the processes of learning are changing dramatically, and "push" and "pull" are very appropriate idioms for what is happening. In other more recent research, it was found that the members of a research team did not appreciate the importance of understanding technology:

> *"Only few members of the research team foregrounded the fact that emerging technologies were not well understood or researched. This perception could be fuelled by the fact that these technologies are often used by students and thus in spaces that are not easily accessible for lecturers or researchers, echoing what the Committee of Inquiry into the Changing Learner Experience (CLEX) report calls 'invisible learning spaces' and might also be linked to members' diverse levels of experience with researching emerging technologies." (Gachago et al 2013:12)*

Gachago and her colleagues concluded that:

> *"… emerging technologies are the domain of a few individuals who have the impulse to innovate, and … may be intrinsically motivated ... by the enjoyment to be had when engaging with these technologies." (Gachago et al 2013:12)*

Once again, different strokes for different folks … it might be true that only a few individuals might make the requisite commitment to technology, but previously other experts have made earlier, more sweeping assertions, that seem to imply that everyone must commit:

> *"Any institution should be equipped with up-to-date technologies, but just having them does not lead to a solution, if you suffer from other issues like teachers' and students' technological competencies and needed course materials." (Gülbahar 2007:956)*

Perhaps the years between Gülbahar and Gachago have allowed us to understand more clearly that we must be selective, and (as we have already noted) we must appreciate the differences that exist in people, in technologies, and in contexts.

[6] Provided they have long hair! See: http://www.youtube.com/watch?v=mIgIgYNdD5E, or just search for "vacuum ponytail"

The "internet of things" – but not yet, perhaps

Dealing constantly with new technologies is quite a challenge, and it has been for some time. Right now, one of the most significant changes is that devices of all kinds are increasingly "intelligent" and "connected". It is almost 10 years since Cook and Light cautioned us about the "internet of things", although they referred to it as a "network of things" (and perhaps they did not actually anticipate a world where it is already possible to buy Wi-Fi -enabled light bulbs, and kettles):

> *"This paper is fuelled by the need to examine current trends in the use of ICT to enable participation by individuals and groups who have normally been excluded. As was mentioned above, pervasive computing promises a 'network of things ', a joined-up world where learning can be conducted anywhere, at any time, about anything. An emerging question must then be: How can people understand the potential of what is within their grasp" (Cook and Light 2006:59)*

This is an absolutely critical point: the technologies that eliminate distance and time present an individual with an incomprehensible array of sources, and opinions, and facts, and therefore the critical new competency (about which we could find no focused research) is the ability to make appropriate judgements about the suitability and reliability of information that comes from these vicarious sources.

Learning objects, a product of technological thinking?

Another consequence of systems, as much as of technologies, is the tendency to adopt structured and hierarchical approaches to things educational. This has happened in different ways and at different levels: the structuring that is applied to *learning design* and the placement of courses in *hierarchies of nationally adopted topics* is possibly welcome, but in the another direction the emergence of the "*learning object*" has commanded the attention of educators widely, and not only those coming from a technical background:

> *"when I speak of learning objects, I am referring to representations designed to afford uses in different educational contexts. They reside in digital repositories, ready to be located and utilized by those involved in educational activities (e.g., teachers and students). These representations address: (a) key concepts from disciplines, in visual and often interactive ways not permitted with previous technologies, for sharing of socio-historical heritage of humanity (our knowledge), (b) information and data that can be useful in the context of developing disciplinary-specific thinking, culture of practice, spirit of inquiry, theoretical knowledge and information work, (c) presentation of small, instructional sequences and demonstrations delivering encapsulated descriptions of some aspects of subject matter which can support learning processes by providing "just-in-time" information, and (d) simulations of key equipment, tools and processes from a discipline to enable development of deep understanding of artifacts used in a culture of practice." (Churchill 2006:495)*

If these ideas of structuring can be made to work (it is not yet certain that they are) then the benefits might be very significant, if Churchill is correct. This is taking us a long way away from traditional learning, which has more often been an interaction between teachers and learners, both responding to a loose structure for learning that simply guides rather than determines exactly what is said and what is taught. On the other hand, a tight structure may be very appropriate when learning specific technical skills, such as network engineering and computer programming, and when learning at a distance. We now begin to touch on critical pedagogical issues, arising from the introduction of technology and structured thinking, which are not yet resolved.

Management

Local research has made very clear the need for adequate management of information technology and information systems in education. Czerniewicz and Brown have identified what might be referred to as different philosophies of institutional management of e-learning (the reader is

encouraged to refer to the original paper for more detail about the types of institutional structure and thinking that they identify):

> *"However, the concepts we have used and the findings in this study suggest that policies are indeed needed, and that supportive, flexible, non-restrictive institutional policies would be the most useful frames for staff innovation in the classroom and for the varieties of pedagogical practices needed to foster effective e-learning. This suggests that either a Structural Collegium Institutional Type or a Structural Enterprise Institutional Type would be closer to the kind of coalescence needed for sustained, effective e-learning use and innovation in support of learning and teaching in higher education" (Czerniewicz and Brown 2009:130)*

The essence of their argument is that there are different strategies for organising education and the use of technology, and policy makers and senior education managers need to understand and decide which way to go, otherwise there will be contention and confusion between players with different beliefs and expectations.

Czerniewicz and Brown's ideas are important and need much more promotion and attention than they seem to have achieved; further, e-learning is only *part* of the story. According to the way that senior management decides to go, there will be different modes and styles of leadership and different requisite management competencies. Much more work needs to be done on this but there was some evidence in the discovered research papers.

Leadership

Vanderlinde and his colleagues have examined the way that leadership works, its importance, and the means to render it effective:

> *"Analysis of research on leaders' impact on teaching practice and student achievement conclude that effective leaders employ three broad categories of leadership practices: (1) setting direction, (2) developing people and (3) making the organization work." (Vanderlinde et al 2012:508)*

The first of these three leadership practices, setting direction, is closely related to the development and adoption of a vision that makes clear the destination that an institution seeks:

> *"the most important function of institutional leadership may be to create a shared vision that includes widespread input and support from the faculty and administration, articulates a clear educational purpose, has validity for stakeholders, and reflects the broader mission of the institution" (Uys 2007:251)*

Engaging with stakeholders is important and other research has made clear that successful change management depends centrally on management hearing and understanding the messages that come from below (Braganza, 2000). It is therefore alarming that in one study in Europe it was found that …

> *"… only half of these 16 schools collected the input of teachers and only a handful used data in the creation of the plan." (Vanderlinde et al 2012:517)*

Paying inadequate attention to the needs and feelings of teachers seems like a fundamental error, and an example of extremely poor leadership.

Managing stakeholder groups

The importance of stakeholders has already been highlighted in this review, and touches on generic management techniques for taking careful account of all those who have a direct interest in an enterprise, and the hopes and expectations that drive them, and the appropriate targets that must be met to fulfil their expectations.

One of the principal stakeholder groups that has proved very difficult to manage in some South African schools comprises the school governors, who have to make a commitment to the interests of a school but may not always have the management skills to deal with the issues that they face:

> *"Accounts from participants in this study paint a picture of school governance beset with challenges of executing governance functions. It is clear from the participants' responses that there are difficulties in understanding governance, mainly because governors perceive their roles differently, which detracts from their main responsibility — promoting the best interests of the school. This, combined with less than adequate capacity-building as required by the School Act, adds to the ineffective execution of functions." (Xaba 2011:9)*

Not all stakeholder groups are found to be so problematic. Beyond the governors (and parents, and others at the edges of a school or university) we have local communities of different kinds:

> *"Some universities already have experience and commitments that are now relevant to community development information and training through ICTs and tele-centers. For example, universities have been involved in extension, a system designed to link researchers with potential users of their research." (Roman and Colle 2003:88)*

In an interesting and authoritative analysis of aspects of technology in learning (in the USA), Evan Straub reminds us that this is not all about "e-learning" (hopefully this review has already established that this is the case), there may be a future where systems become integrated across stakeholder groups:

> *"Finally, administrators need to keep in mind that technology adoption implications extend past direct pedagogical integration. Changes in peripheral systems like student information systems, payroll systems, and even changes in the phone system may have an unanticipated effect on teachers' environments and, therefore, attitudes toward technology. Even changes in informal technology can affect the dynamics of the school. Informal technologies like cell phones blur the lines between social, work, and home lives. These informal technologies may in tum result in a more formal use, such as mandating cell phones as a means for an emergency contact. As technologies become more pervasive, so do the pressures to acquire the skills to successfully use or leverage them. Administrators may need to recognize that just as the lines between informal and formal technologies are blurred, so too are the lines that delineate pedagogical and nonpedagogical technologies. " (Straub 2009:645)*

A more detailed review of the literature would reveal a wider range of stakeholders than just administrators, governors and communities, but space here precludes this level of detail. The principle has been established, that stakeholder interests are important to successful management.

The need for management competencies

Xaba (quoted above) also notes that certain management competencies are critical to success, and might have to be put in place to support and capacitate the governing body:

> *"It is recommended that full-time posts for specialised functions like financial management and resource management be created, either at schools or districts. Functionaries appointed to such posts would then deal with these functions on the basis of individual schools or school clusters, thus assisting governing bodies and simultaneously playing an overseeing, monitoring and controlling function." (Xaba 2011:9)*

However, in the Western Cape, built-in support systems proved inadequate to achieve good management, and failed to adequately support the teaching work at the front line. The absence of any effective management involvement is implied by what happened:

> *"all the Khanya schools had a computer committee consisting of a few teachers … the facilitators [appointed to assist them] were the weakest link in the whole implementation process" (Gudmundsdottir 2010:182)*

This is not a new problem. Mestry (2006:27) examined these kinds of issues generally some time ago, using qualitative methods and focus groups. His paper calls for school governing bodies to play their role in the financial administration of schools as control and overseer, and refers specifically to portfolio management. Disappointingly, he makes no reference to the benefits of ICT use, the need for special skills to deal with ICTs, nor any shortcomings that might arise. This otherwise excellent

academic work failed to acknowledge that *information systems are needed* to support educational management, and in the case of school governors such systems could provide real support where specific competencies are missing.

Lessons from "real" businesses

Before leaving the matter of management, it is worth noting that there may be messages for education managers from wider experience in business. This review was not confined to published *education* research, a small number of other papers give insight into how businesses have succeeded with the management of information technology and information systems. Such a study gave insight into the role of a "chief information officer" (CIO):

> *"… there may be two types of CIOs … CIOs who focus on IT initiatives for* differentiation *and CIOs who use IT for* efficiency. *This logic is consistent with the resource-based view that calls for complementary managerial skills that, when used in combination, can create value." (Banker et al 2011:501)*

This allusion to differentiation and efficiency might strike educators as odd, and not relevant to the field of education, but there is at least one university that now speaks publically about its recently appointed "Chief Information Officer". Following from Banker's comments it is clear that the differences between different kinds of school (and university, and further education college) demand quite different strategies. Efficiency is highly desirable, especially in the case of presently dysfunctional institutions that are simply not working; differentiation is equally desirable in higher education, for example where a university is trying to establish and sustain an international reputation in a highly competitive sector. Dealing with these choices, gaining support, and implementing them, is the job of the Chief Information Officer.

Implementation

In the three main sections above this review has looked in turn at education, technology and management. The selected papers (and the extracts from them) are hardly a complete treatment but they bring out some of the issues that are important to South African education at this time. What has also come out of the review is that the *implementation* of changes that are related to educational information technology and information systems is difficult.

First, we must note that the scope of educational information systems extends over time to embrace more and more of what we are doing in schools and universities. For at least ten years, the divide between administrative and academic systems has been taken as fact, but some have argued that our "islands of automation" will not prevail:

> *"Finally, administrators need to keep in mind that technology adoption implications extend past direct pedagogical integration. Changes in peripheral systems like student information systems, payroll systems, and even changes in the phone system may have an unanticipated effect on teachers' environments and, therefore, attitudes toward technology. Even changes in informal technology can affect the dynamics of the school. Informal technologies like cell phones blur the lines between social, work, and home lives. These informal technologies may in tum result in a more formal use, such as mandating cell phones as a means for an emergency contact. As technologies become more pervasive, so do the pressures to acquire the skills to successfully use or leverage them. Administrators may need to recognize that just as the lines between informal and formal technologies are blurred, so too are the lines that delineate pedagogical and nonpedagogical technologies." (Straub 2009:645)*

Straub's paper is an authoritative analysis of technology in learning within the USA, and it seems that this is a discourse that has not yet emerged in South Africa (at least, as seen through the reviewed academic research). Much of what we see written about implementation is more prosaic, being concerned (for example) with issues of language, or the choice of the best learning support systems for a subject area.

Language, literacy and learning dependency

Surprisingly, for a country with eleven official languages there is not a lot of attention to issues of technology and language in education, even though general issues of language are predominant in work and life in South Africa.

One paper stands out as a useful empirical examination of what actually happens in the classroom (but again, without any regard to the relevance of information technology and information systems):

> *"The emphasis on mother tongue instruction is not controversial in the Western part of the world, whereas many African countries are still using colonial languages as the language of learning and teaching. Comprehensive research on language of instruction in Tanzania and South Africa project indicates a strong connection between the home language as the [language of learning] and learners' positive learning processes." (Gudmundsdottir 2010:176)*

It is hardly surprising that home language proves to be the most effective vehicle for learning, especially for the young. But because appropriate *content* is so critical to successful e-learning as learners progress, it follows that literacy and the use of appropriate languages becomes a critical issue.

> *"If e-education continues to be the preferred champion of information literacy then clearly more research is needed in the impact of the new ICT projects on the learning in the project schools. The research should look beyond the mere provision of computers and access to the internet and rather assess the impact on the information literacy of learners and educators … " (Hart 2007:44)*

As if multiple official languages were not enough of a problem, the rise of "SMS" language (and grammar, and spelling) is a problem:

> *"educators were of the opinion that SMS language is negatively influencing the written language skills of Grade 8 and 9 in English as Home Language" (Geertsema et al 2011:485)*

Equally, considering how important it is to take advantage of the best resources available in delivering education, it is surprising that information technology and information systems as a resource *for different subjects* has not received much attention in serious academic research. A particular case is the teaching of information systems and technology:

> *"This has traditionally been even more difficult in an information systems or information technology curriculum in which actual industry software tools are often used. The issue of determining the most appropriate software tools for instructional purposes is not new, but as the tools keep changing and evolving, options may also change" (Parker 2010:255)*

The problem of the rate of change of technology presents itself yet again. But where we do make a choice, other problems are just beginning: Top of the list is that people do not always react with enthusiasm when faced with changes to the ways that they work.

Getting people on-side

Following ten or more difficult years with shifting ground and a home-developed learning management system, one university has won over the affected academic users, in different ways:

> *"Through eLearning lunch-time seminars, departmental visits, training and consultation sessions, the blog communication strategy, annual eLearning colloquium and the eLearning incentive initiative 'reward the educator'—[UWC] has been successful in terms of getting academics on board on a voluntary basis, in a complex environment … a reflection on the adoption of eLearning by academics at UWC clearly indicates that the non-coercive approach has resulted in the voluntary buy-in and in some cases championing of eLearning by academics." (Stoltenkamp & Kasuto 2009:46-49)*

Training often features as important:

> *"No description of the integration of ICTs into teaching and learning environments would be complete without addressing the issues of training in both ICT and technology-specific skills, and*

> *of ongoing technical support ... all teachers who participated in this study were provided with four days of training prior to being asked to use the equipment in their teaching. For some teachers, however, it app eared that this was not enough." (Slay et al 2008:1328)*

Based on the work that we are familiar with, in the Western Cape, we are not surprised that four days' training proved to be insufficient – achieving change on this grand scale will take a great deal longer, and it is interesting to find that in some institutions (at tertiary level, in the USA) the students themselves have been allowed to make a contribution:

> *"Consistent with the expectation that faculty and administrators model the use of innovative technology applications, a new process for knowledge and skill development was implemented. Referred to as the SWAT Team (Student Wizards Assisting Teachers), technologically-advanced undergraduates were teamed with teacher development faculty, the goal being to provide just-in-time training on an individual basis, tailored to the unique needs of each faculty member." (Wedman and Diggs 2001:429)*

Would this work in other countries? Yes, of course it does, for example in Israel:

> *"At this level the teacher functions as subject expert and the student as computer expert. This interaction eventually makes the teacher more familiar with the technology and the students more knowledgeable with the subject under study … a group of 40 computer trustees (out of about 600 students)" (Tubin et al 2003:134)*

But this idea of empowering the learners will make extreme demands on establishments with a well-established and unmoveable *status quo*. If we turn to the Far East, despite the awe in which we hold the educational achievements of the "tiger" economies that have flourished there, Lim and Chai found that

> *"… it is a fallacy to assume that teachers will rethink the planning and conduct of the teaching and learning activities … until teachers' pedagogical beliefs are transformed, there may not be changes in the way they use computers in the classrooms." (Lim and Chai 2008:808)*

So, getting the learners to help by teaching the teachers sounds like a great idea, but in cultures such as those in the Far East it face some cultural difficulties. Elsewhere, in a study of teacher-learner relationships in Canada, Davidson and Desjardins found that the learners were more in control than the teachers (see below for translation):

> *"Cette absence de relation peut indiquer que pour ces participants, les activités pédagogiques ne relèvent pas du contrôle de la personne enseignante, mais bien des étudiants. Cela peut s'expliquer par le fait que la formation à l'enseignement vise la préparation à une pratique professionnelle et, dans le cas de ces participants, la formation est de courte durée. Dans cette perspective, il est possible que la représentation de la pédagogie centrée apprenant change selon le contexte de formation, qui changerait aussi selon les provinces Canadiennes.*
>
> *[This lack of relationship may indicate that, for these participants, educational activities are not within the control of the teacher but more within that of the students. This can be explained by the fact that teacher education is preparation for professional practice, and in the case of these participants the training is short-lived. From this perspective, it is possible that the representation of the learner-centered pedagogy changes depend on the context of training, which would also change according to the Canadian provinces]" (*Davidson and Desjardins *2011:61)*

This is an interesting insight into the actual complexities that must be addressed in managing the implementation of new educational systems in support of educational activities. In some cases it seems like a balance of capability between teachers and learners, in others it is the balance of power. Yet another area where more work is needed that takes full and proper account of the effects and impact of educational technology and new information systems.

Educational information systems

Turning to the specific matter of the information systems that might be used in education, some interesting research helps us deal with the different types of information system that might be available. Quoting other work, Parker gives us a simple typology of systems that might be used in the classroom and he touches on the ways in which we might evaluate them:

> *"Educational software generally seems to 'be of five basic types: tutorial, drill and practice, simulation/game, information, and management and assessment' (Ahmed 2003 , p.2). Plaza et al. (2009) provide a thorough and excellent literature review regarding evaluation of educational software. Some of these studies propose criteria that seem appropriate when evaluating many types of software tool. While checklists are commonly used in selecting educational software, several studies note serious problems with the checklist approach, including a focus on technical rather than educational issues, unknown validity of criteria, shortcomings for assessing quality and instructional efficacy, lack of tailored criteria, and a reliability on past usability evaluations that makes them inadequate for evaluating new and innovative user interfaces (Bednarik et al. 2004 ; Hosie et al. 2005 ; McDougall and Squires 1995 ; Squires and McDougall 1994 ; Squires and Preece 1996 ; Squires and Preece 1999 ; Tergan 1998)." (Parker 2010:259)*

It would seem that these thoughts are more advanced than what is typically found in South Africa, although there may be equivalent work here that we have not yet found. Parker also talks about the inherent qualities of good educational information systems:

> *"Ideally, software would be readily available for students to perform homework exercises, practice and reinforce course concepts, and develop functional projects. Software tool use in a course should simulate as closely as possible an enterprise experience. However, given the complexity and expense of most enterprise-wide systems and the limited free time that most instructors have to learn, install, implement, and teach such systems, careful consideration is required to select software that will offer the most valuable educational experience to students. Both students and instructors should be able to focus on essential course concepts rather than struggling with details of a complex technical software product." (Parker 2010:256)*

In referring to "enterprise experience" and "enterprise-wide systems" Parker is reinforcing the argument that the scope of our educational systems is expanding continuingly, and he is alluding to the widespread industrial and business adoption of "Enterprise Resource Planning" (ERP) systems that do, in effect, embrace almost all of what a typical business might want to do. We must expect that this trend will continue in education.

Consequences

There is some reported work that highlights the *consequences* of implementing information technology and systems in education. As we have already noted, developing strategies is relatively easy but implementing them and achieving targets that have been set can be a nightmare.

One paper dealt principally with administrative systems; another looked at the contribution of technology in the teaching of mathematics (as a subject); others report variable experiences elsewhere internationally and in the research field.

Early concerns

McClea and Yen (from the USA) take the stance that technology as a tool can be used to collect meaningful data that can improve educational performance administratively, by saving money, evaluating user experiences and preferences, and communicating better. Using appropriate systems, policies can be evaluated more effectively and important (even immediate) feedback is possible. These ideas about immediate feedback point towards much more recent issue of *learning analytics* – inspired by web analytics, already talked about at educational meetings and conferences, but not yet reported in the literature.

But back to the present: according to McClea and Yen the role of ICT in administration should be to lift the burden of repetitive entries, so that human relationships can be enhanced. They see the need to balance these things carefully:

> *"The benefits of information technology offer the capability to enhance the specific goals of the institution admission department but the obstacle may be the dilution of the profession. According to one expert: I worry that the emphasis on controlling costs and streamlining the delivery of knowledge and supplementary services might dehumanize education and impoverish students." (McClea and Yen 2005:93)*

In South Africa the quality of some educational administration can only be improved, but whether we would have to balance these same issues, or recognise others, remains to be established. There is at least one interesting report of the advantages of technology in the classroom, assisting in learning particular aspects of mathematics.

ICT helps learning but socialisation adds to the technology burden

Ogbonnaya provides an interesting but very focused example of information technology in the South African classroom. The results seem positive but not dramatic – it is interesting that the "community" or "social" aspects of using ICT came through strongly, reinforcing the need for a careful and extended analysis of all the issues before presuming the benefits of new ideas such as this:

> *"One student said: 'I was able to understand, we had great opportunities to do maths together' … the findings from this study show that the students performed better in parabolic functions assignment and test after the use of the software compared to when they learned in the traditional pattern of teaching and learning … Looking at the findings of this study through the theoretical lens of activity theory, it is evident that the ICT tool (the software), the rules, the community (the students and the teachers) and division of labour (the cooperation among the students) mediated the lesson activities that supported the students to achieve higher-order thinking." (Ogbonnaya 2010:10)*

But students will not always do what is expected, even at university there are have been unintended outcomes:

> *"Among useful unintended outcomes, we found that students were accessing online databases only from the laboratory attached to the library, under the misapprehension that these were not accessible elsewhere. We also noted the dominance of web-based email accounts that use up scarce bandwidth, despite the allocation of local email addresses to students." (Czerniewicz and Ng'ambi 2004:245)*

Getting capacity planning right at the start might therefore be difficult, and then it is important to measure the actual benefits achieved.

Measurement

Reports of actual or intended benefits raise the interesting question whether they can be measured. Vanderlinde's work in Europe suggests that this is not always done:

> *"Only six schools created the means to monitor the feasibility of the plans they were developing." (Vanderlinde et al 2012:517)*

This is yet another area where management experience in business generally has shown that it is critical to properly identify benefits at the planning stage, and then to *pursue them energetically during and after implementation*. There are important messages here for policy makers and management in South African education.

International and South African experience compared

In order to summarise these thoughts about managing the consequences of information technology and systems in education, Emily Wong's experiences in Hong Kong offer some useful summary thoughts on how to plan strategically for different kinds of benefit:

> *"Lastly, findings of the study have clear implications for improving school effectiveness. To unleash the power of ICT implementation, practitioners should first make clear what improvements they are looking for. Is it improvements in traditional processes and knowledge? Or is it new reasoning and new knowledge that might emerge from the use of ICT? Next, educational practitioners need to expand the concept of ICT implementation from mere ICT use to ICT use in the context of pedagogical and organisational interventions. If school effectiveness, from teacher perspectives, is found to improve in a context of establishing collegiality to foster pedagogical innovations, then school administrators and policy-makers should give more attention to both the social contexts and institutional culture in which teachers are situated. The climate of collaboration and the collegial exchange in ICT experiences are some examples that merit attention. At the same time, it also offers insights into the appropriate direction of education reform. It is worth pausing to consider whether to adopt a control strategy or whether to adopt a commitment strategy that seeks to develop innovative working arrangements supporting teachers' decision-making and increasing teachers' engagement in the tasks of teaching. Further, policy-makers are urged to review the impact of adopting private sector practices to tighten control of educational process and the work of professionals and to consider whether the dominant ideas of economic rationalism and managerialism will really increase or worsen educational outcomes." (Wong and Li 2008:115)*

It is interesting that she reminds us of the potential benefits of adopting private sector practices. The management of technology in education may have a great deal to learn from the private sector, with no threat to the underlying effort to provide education other than to improve its efficiency or its effectiveness. This theme of learning from general management practice is one that recurs in some of the studied literature. But turning back finally to South Africa, we find that it is a pity that national initiatives in South Africa seem to have failed to move things forward, because of fundamental problems in the education "system" as a whole:

> *"… these national reform initiatives have not been entirely successful , since they have added more residual rules and accountability mechanisms to school organisation. These actions compromise the educator's potential of raising standards of teaching, learning and achievement in conditions where learners are disillusioned with schooling and educators are struggling to make noticeable strides in diverse, overcrowded classrooms and to meet the increasingly bureaucratic demands of accountability to parents and employers (Leitch & Day, 2000:189)." (Rossouw 2009:13)*

It is possible that trying to fix a broken educational system with information technology and information systems will only make it worse, and the idea that educational institutions should pre-qualify themselves before making major investments is a very useful one.

Research notes

A review of such a large number of articles about information technology and systems in education throws up some observations about research: the methods that are adopted, and the scope of research that is attempted.

The scope and approach to education research

Laura Czerniewicz considers that this is an emergent field and that there is still a great deal that needs to be studied, from different perspectives:

> *"Since there are so many aspects of the work that are little understood and which are in the process of being named, formulated and investigated, it is important for researchers to recognize and operate with different world views, especially when working with the range of disciplines in*

> *which educational technology practice is located. A commitment to respect and open mindedness across existing clusters and sub-groupings will serve the interests of the educational technology research community and strengthen the work undertaken in this emergent scholarly field." (Czerniewicz 2010:531)*

Prior international opinion begins to put some structure on the ways by which we could proceed from here:

> *"While one ought to be skeptical about dramatic improvements in learning due to new technologies, one cannot ignore what is happening in education due to the advent of the Internet. Networked learning certainly has the potential to improve learning on a global basis and will surely influence the future in many ways. However, there appears to be little systemic understanding of how these changes will evolve. I shall close with five principles that I regard as fundamental for effective use of technology and for improvements in learning and instruction:*
>
> 1. *Learning is fundamentally about change − the Learning Principle.*
> 2. *Experience is the starting point for understanding − the Experience Principle.*
> 3. *Context determines meaning − the Context Principle.*
> 4. *Relevant learning contexts are often broad and multi−faceted − the Integration Principle.*
> 5. *We know less than we are inclined to believe − the Uncertainty Principle.*
>
> *If we wish to come further than we have in advancing education, then such principles should guide research and development. The Uncertainty Principle is perhaps the most fundamental of all and serves as a reasonable point of departure for educational research. Educational technology will have arrived when it" (Spector 2001:35)*

One might agree that the degree of uncertainty in South Africa exceeds that which is faced in many more developed countries, such as in the USA (where Spector is based) – his high-level view of the principles involved is useful and has been quite frequently cited in subsequent work.

Research methods

However, there are more practical issues with research, such as the most appropriate methods of research to be chosen. Your reviewers have a strongly held view that at present *quantitative* methods of research in this new field have limited usefulness when compared with qualitative methods. Recent local research has argued the case for qualitative research:

> *"It may be argued that quantitative data can never fully come to fruition without the necessary counterbalance of qualitative examination. It is hoped that future research endeavours will tackle this issue in more depth, especially the reverse condition – qualitative data augmented by quantitative elements." (Fanni et al 2011:13)*

But qualitative work has to be done properly, and the rules of working this way are less clear:

> *"Papers of quantitative nature were almost twice as common as qualitative papers. Overall the mixed studies approach was the most common approach used. Qualitative research was often inadequately described or not conducted with the same rigor as was evident in many of the quantitative studies. This tendency to quantitative research possibly reflects the backgrounds and biases of the researchers involved, with many coming from computer science backgrounds." (Sheard et al 2009:101)*

If this really is an emergent field, and we believe that it is, then we cannot be sure which variables will accurately describe what is going on, nor even what variables might be available. Hence quantitative research will be of limited reliability and it is important to undertake the qualitative work that will examine the phenomenon with a more open attitude, and tease out the variables and their relationships from careful examination of the experiences, attitudes and perceptions of all those who are actually involved in education. As an un-dated report on technology in education in South Africa notes:

> *"Most importantly, there is an emerging research community that is increasingly seeking to make a critical and contextualised contribution to central academic debates in the international arena.*

> *While it is clear that ICTs are now very much part of the higher education landscape in the country, it is equally incumbent on all players within the higher education sector to ensure that they work in ways that are educationally sound, and not simply for their own sake." (Anon n.d.:24)*

Not just higher education, *all* of education needs to be studied and understood.

Finally, with research in mind (and having noted that the very nature and form of education is changing), it must be recognised that there are fundamental changes at hand in the management of *intellectual property rights* and that this affects research and publication. Stephen Mutula has studied the challenges of doing research in sub-Saharan African universities, and the opportunities that arise from what he terms "digital scholarship":

> *"There are questions of intellectual property rights, privacy and trust which must be addressed by researchers … Most of the content providers of digital material are in the developed world, and they are increasingly moving away from the purchasing model to licensing, which often overrides conventional exceptions to copyright as contained in national legislations, such as fair use and fair dealing … Scholars should be encouraged to self archive pre-prints and post-prints of their papers in open access archives or institutional repositories to help address the paucity of research materials that face African universities … Libraries have know-how not only in managing, providing access to, and preserving scholarly resources, but also in forming federations and collaborations to share published scholarly work." (Mutula 2009:10)*

One might hope that, as the adoption of information technology and systems proceeds, the limitations and handicaps of geography will diminish; but Mutula provides a useful caution that trends in the licensing and rights of access to academic work must be monitored and used to ensure that South Africa does not fall further behind in the international competition to make the best of the opportunities that are available. For education and the research that supports and feeds it are certainly becoming more and more international. The future is not about South Africa alone, it is about South Africa in a highly connected and competitive world.

Summary of the review

It is not necessary to linger on the fact that **things are changing**, although there is considerable evidence that in South Africa the ability of education institutions at all levels to accommodate and successfully manage change is very limited. The statistics suggest a very **poor overall picture of educational performance**, but some of the good stories from individuals are indicative of what can be done, and some of the **work that has been done by individuals** to understand the management of information technology and information systems issues in education is exemplary.

The diversity of capability, experience and outcome in South Africa makes clear the **need for research that will deal with the differences** that are to be found: in technologies, and in teachers, learners, communities and contexts. "One size" does not fit all, and the management of information technology and information systems in education needs to recognise these differences. There is too little comparative evidence that makes clear **the most appropriate response in different situations**. Perhaps the most significant difference, that is implied rather than explicit in the reviewed literature, is the fact that some institutions are very early in the cycle of technology adoption and others are very advanced. There is clearly **a life-cycle of maturity** that makes the needs of early and late starters very different. Statistical research can easily mask this truth, whereas case study research digs deeply into people's expectations, experiences and perceptions and makes clear that maturity is important. Many accomplished social science researchers would agree that **managing *expectations* and *perceptions* is more important** than managing *actuality*.

Hence, the fact that the review has discovered and focused on **stakeholder issues** is very significant. Techniques for analysing the needs and expectations of stakeholders are well established in the management sciences and are waiting to be deployed in the field of education. The review has

exposed the word ("stakeholder"), but there is **little evidence of an adequate response** by researchers and education managers.

With stakeholders in mind, we realise that successful education is about **much more than just teaching and learning**. It demands attention to issues of culture, a recognition of the importance of people, attention to the sociology and socio-economic conditions that prevail in the context within which education happens, and – perhaps most worryingly – an acknowledgement that **the business of education is complex**. Superimpose the management of new information technology and information systems and we have a serious challenge to deal with. While many believe or assume that information technology and information systems are a solution to problems, the truth is that they impose **high levels of change**, depending on whether the objective of the investment is **simple efficiency** (that implies there will be not much change to what is done, it will just be done more easily) or **higher levels of effectiveness** (which implies significant change, because the way that we work will have to respond to technology-related opportunities to do things differently).

At the heart of the matter, technology is the main driver of change. It is well known that information technology and systems have eliminated many of **the problems of time and distance** – it is available constantly, and conversations can take place globally at little or no cost. This is a huge change from the situation just 20 years ago, when the internet and the World Wide Web were of interest to only a small minority. But there is a further even bigger change to come, as the "**internet of things**" encroaches on all aspects of life. Already it is possible to buy light bulbs and kitchen kettles that are Wi-Fi enabled. We might smile at this idea today (and observe that such devices are ridiculously expensive to buy) but as the data that we begin to generate in all aspects of our lives accumulates, informing the data-gatherers about what we are doing (so that they can ponder on the reasons why we are doing it?), we will hear more and more about "**learning analytics**".

Why **should we not measure** how quickly learners type their work? Monitor how long they have been working on a document? Analyse all the searches that they did on the Internet? Build graphs of who they talk to, and for how long? The **volume of data** that we might choose to gather will increase dramatically; how we choose to justify gathering it remains to be decided, as does the whole matter of the ethics of doing so.

Management is sometimes summarised as four simple steps: "Think", "Plan", "Act" and "Check". This is a useful starting point for a discussion of management in the present context.

- A detailed reading of this review reveals that the strategic issues in education continue to confound us, and it seems that information technology and information systems are compounding the problems of strategy formulation and implementation. **Careful thinking is therefore needed,** and it is not easy to assemble all the issues and find the right balance in planning the way forwards.
- Because this is an emerging field and will continue to be so for some time to come, **planning requires compromise** in terms of time horizons: academic planning is more or less confined to annual cycles of registration, teaching, examination and graduation; unfortunately technology drives on relentlessly on a weekly and monthly basis.
- The implementation of strategy requires that we **act according to our plans but also within our capability**. Setting targets that cannot be achieved will disappoint and demotivate involved persons. The limitations of the contexts within which education takes place has to be recognized and incorporated into planning, so that often before technology investments can be made to work there are required investments in infrastructure and human resources.
- Finally, **checking that what we hoped to achieve has been** achieved requires a brutal honesty that is not always forthcoming. Agreeing the intended benefits, setting targets and then honestly measuring what eventuates is critically important but almost universally difficult. A project manager responsible for technology implementation will claim success based on "on time" and "on budget", but one or two years later teaching staff and learners

might still be frustrated by technology that does not work reliably, is difficult to maintain, and is already obsolescent.

In order to ease the problems of managing new information technology and information systems in education, one of the ideas that emerges strongly from our detailed review of the literature is the **need for a "Stages" model** that makes clear the differences between early and late stages of adoption and implementation of technology. Such models are evident elsewhere: in software engineering, personnel assessment, process management and supply chain management, and inform our understanding of benefits. In the beginning we seek **the benefit of understanding** (which implies the risk that we might fail, and yet learn by doing so); much later we would rather seek the **benefit of internationalisation**, confident that we have learned all the tricks of the trade and recognising that we have an opportunity to export our capability to other countries in Africa, or even globally. We now know that in the beginning things can be chaotic but as control is brought to bear upon our work, as measurement and adjustment becomes possible, in the later stages of maturity our human and organisational **systems can become self-managing and self-improving**.

This is a good moment to draw the discussion to a close. There is a strong hint here that in education **we can learn from experience in "real" businesses**; we have noted that boundaries are dissolving but we can now see internationalisation as an opportunity to aim for; we have noted that there are capability and power struggles between teachers and learners but the maturity idea helps us to see more clearly where the risks are and how we could ameliorate them. Most important of all, the idea that the **benefits of new information technology and information systems are very different in the early and late stages** makes it possible to set reasonable and achievable targets, and then to celebrate success when it is achieved. Finally, this gives a new potential focus for all education research, acknowledging and seeking **a better understanding of the maturing of technology in education**, as time progresses.

Appendix 2: Constructing the Reference Model

This section of the report documents the construction of the reference model step by step, and illustrates the process at each stage from the literature and other evidence that has been gathered. First, however, we need to note that the project plan indicates several requirements of the reference model:

- To be able to identify areas where ICTs may have application.
- To map teaching and learning processes to progression of education (the two principal perspectives)
- To review and assess the potential of ICTs in education
- To locate the potential application domains
- To allow the development of a portfolio view of present and future opportunities
- To populate the model with empirical data

The final requirement, to populate the model, requires the case studies that had to be dispensed with as a consequence of the reduced funding that was provided, however the model provides all the other potential that is listed here, and it stands as a framework that can be adopted for future research concerned with the management of ICTs in education in South Africa.

The requirements above will be reviewed at the conclusion of this section.

Sources

In the present context, finding the things that concern management in dealing with ICTs in South African education involved discussion amongst experts (already summarised at the start), the literature review (also already summarised) and analysis of other extant sources such as could be found such as the Flash MOOC and prior research outputs.

The simple model, already presented, is shown here with annotations indicating the nature of the *four relationships* between the *five entities*:

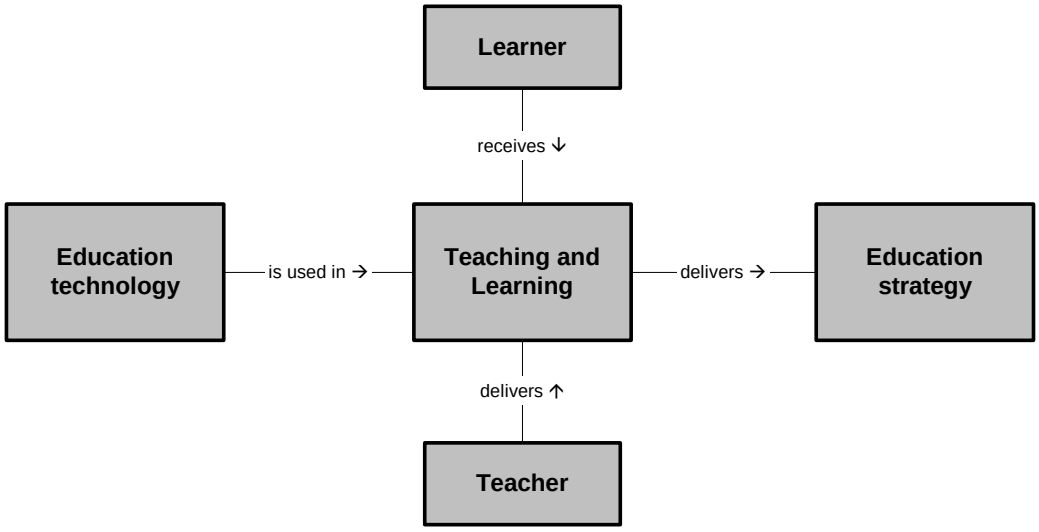


Figure 5: A simple start: teaching and learning, technology and strategy

Constructing reference models

A few comments about the construction and development of reference models might be helpful.

The importance of relationships between entities

In constructing a reference model it is critically important to identify not only the entities – in the above figure they are the rectangles with the words in – but also to identify the way that they relate with each other – the annotated lines that join them. Any model that purports to be a system model that has arrows or lines that are *not* annotated is virtually useless because of the wide range of interpretations that can only be guessed at. Here the relationships are simple and exquisitely clear. We can see that …

learner *receives* teaching and Learning,
teacher *delivers* teaching and learning,
education technology *is used in* teaching and learning
teaching and learning *delivers* education strategy.

Without annotations, the relationships between entities would leave critical aspects of an understanding completely unclear and undefined, hence, as a model is developed, all relationships must be examined and annotated. This examination must include one further consideration: the relationships may hide further entities that need to be exposed, especially when the relationship is a *many-to-many* one.

If in the above model we define "teaching and learning" to be an instance of one teacher conveying knowledge to a class of learners, using a range of kind of technologies but directed at only one aspect of the prevailing education strategy, then we could elaborate the model like this:

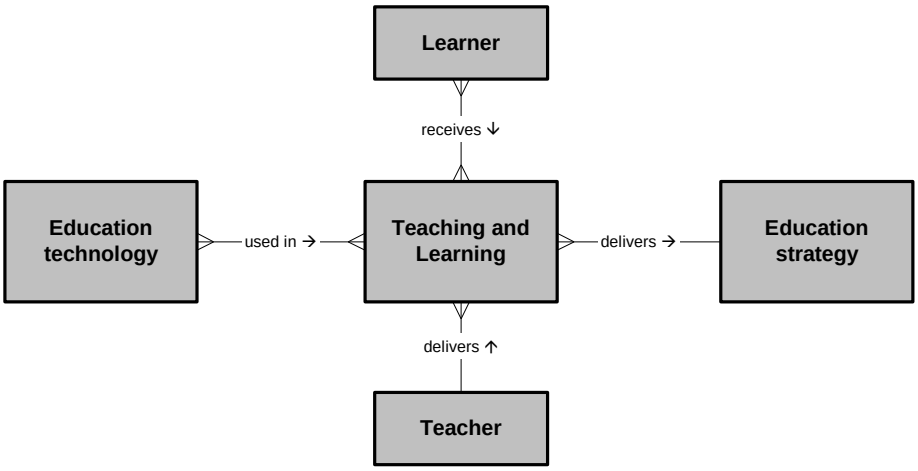


Figure 6: Introducing multiplicity in conceptual modelling

The "crows' feet" indicate multiplicity: Many technologies are used in many different teaching and learning situations; teaching and learning is provided to many learners, who will be taught many different times in the course of their education. In both cases we need to expose a further entity, which can reasonably represent the case where *one* technology is used in *one* class, and where *one* learner has learned *one thing*.

Resolving many-to-many relationships

Consider the case of **education technology is used in teaching and learning**. First, a technology cannot simply be "used in" education without it being embodied in an **education system** before it is useable: a *personal computer* (technology) needs a *browser* (system) before *the internet* (technology) can be used, a *data projector* (technology) needs a *PC* (technology) with a *presentation suite* such as PowerPoint (system) installed in order to present learning material; in all cases, of course, we need a capable user who understands how to use the browser or presentation suite, because the human capability becomes a necessary part of the full "education system".

But, as these simple examples begin to demonstrate, an **education system** will possibly employ many technologies and serve many different educational needs. Many different technologies may be used in many different systems which contribute to many different kinds of teaching and learning; any instance of teaching and learning may employ many different systems and technologies. Hence, if we only study (for example) *interactive white boards*, in *geography lessons*, we will learn nothing about the real contribution of white boards unless we understand the contribution of the *mapping system* that we use in our geography class, and other technologies such as the *Internet* and even the *linked hypertext* that supports the geography lesson. Further, we will not understand the benefits of the white board to the overall curriculum unless we investigate the use of the white board in *all subjects* that might use it.

Things get complex, but we can deal with it.

Beginnings

The "straw man" model

Quite early in the project there was a "straw man" model that stood as a foundation for future thinking about the details:

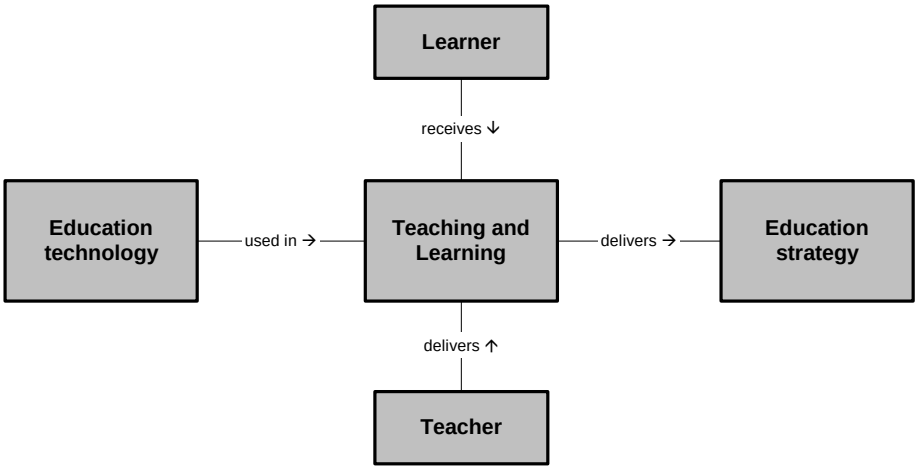


Figure 7: A starting point in developing the reference model

This model is simple and speaks for itself – with teaching and learning at the centre of things, the teacher and the learner identified as the key stakeholders, and technology and strategy set out as the beginning of a chain of value.

A working version of the model

However, things quickly became less clear. A first scan of the evidence that was available made itr clear that other things, all of which seemed to be important, produced a much more complex picture:

- **Knowledge creation and acquisition:** the processes of knowledge acquisition and the storage, reuse and disposal of obsolete knowledge cannot be ignored. Mixed in at this level were considerations of assessment and analysis of education outcomes, but (arguably) some of these elements need to be taken to the other end of the chain of education activity – the delivery of knowledge through education processes.
- **Knowledge delivery and dissemination:** this is the other end of the business of education, embracing all the issues of course design, content development and dealing with learners. Identity management was seen as a typical current issue, recognizing that many learners today have multiple identities and there is considerable scope for confusion (and cheating?).

- **Dealing with the technology and systems:** Separating these two primary areas of activity this early view saw the precursor to education delivery as education *services*. This is an important idea that must not be lost. The provision of **Education IT Services** (for delivery), the operation of **Education Information Systems**, and the **Management of ICT in Education** were seen as three primary areas of activity that sit between **Knowledge creation and acquisition** and **Knowledge delivery and dissemination**.
- Later in the discussions, the **Need for Education** and the **Supply of Education** were recognized as representative of the input and output.

Hence, the following summary was circulated as an early draft of the Reference Model:

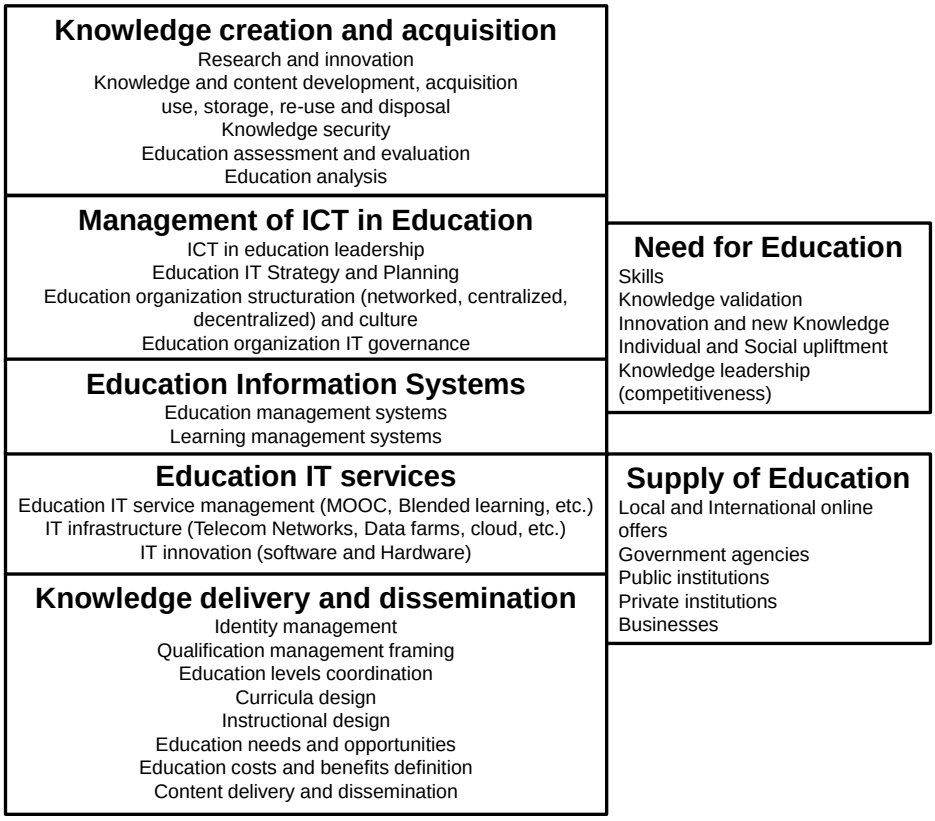


Figure 8: An early version of the reference model

This is a useful starting point, but it is more indicative of the whole education industry rather than the *management of information technology and information systems* within it. The simplest first step, then, is to recognise the primacy of **management** and **management action** as the things that are at the heart of this study. It was a consequence of the great diversity of literature about education (much of it with no reference whatsoever to **technology**) that led to such a complex view as that above. Further, at this stage in the working we have lost the important idea that entities have *relations* with each other, that have to be identified in order to have a meaningful and stable model. Nevertheless, the working model above gives important evidence of ideas that have to be incorporated into a final version of the reference model, or have to be excluded for good reasons.

The development of the final model

Putting in management and management action

Hence, going back to the straw man and the need to incorporate **management** and **management action**, the first step was to combine the two (note that as the model develops in the figures that

follow, in each case the *new* components are shaded in grey and the alreay-existing ones are shaded in white):

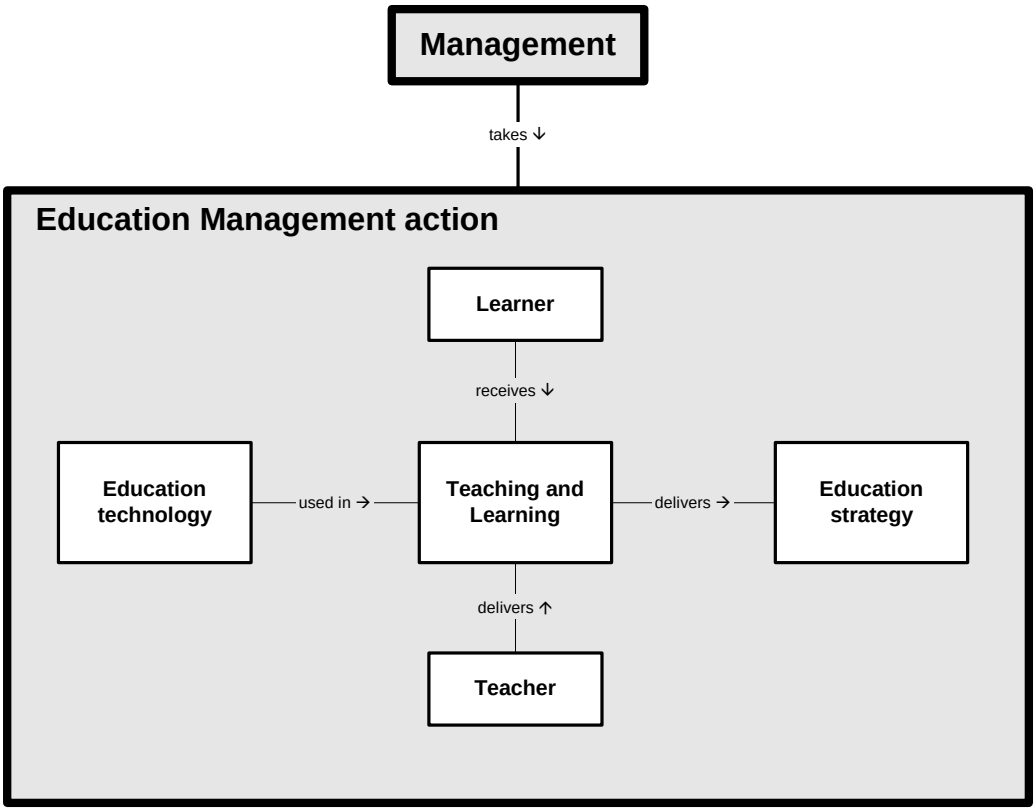


Figure 9: Management and management actions on education

This makes the very simple suggestion that the five elements of the straw man model, education technology, teaching and learning, learners, teachers and education strategy are all things that education management might take action about. This, it can be argued, is reasonable. For example, there are many references to education strategy, some specific and some implied:

> *"… a 'one-size-fits-all' **strategy** for building a learning organisation is unlikely to be successful. It is nonetheless critical that eLearning be seen as part of the normal, traditional teaching-and-learning environment of the institution" (Stoltenkamp and Kasuto 2009:53)*

There are copious references to teachers; here is just one example:

> *"… it is a fallacy to assume that **teachers** will rethink the planning and conduct of the **teaching and learning** activities … teachers with traditional pedagogical beliefs* [**i.e.** "**education strategy**"] *will continue to use **computers*** [**i.e. "education technology"**] *to support traditional skill and fact-oriented instructions." (Lim and Chai 2008:808)*

Equally, there are copious references to learners:

> *"YouTube* [**i.e. "education technology"**] *can be used to create a learning community where everyone has a voice, anyone can contribute, and the value lies equally within the creation of the content and the networks of **learners** that form around content discovered and shared." (Duffy 2007:179)*

And so on. But let's pick up on Duffy's reference to YouTube: is YouTube really a *technology*? Surely it is a combination of many technologies? And without getting in any way involved in the details of strategy, Duffy makes the interesting point that it is *value* that we are seeking – he sees this in the *network of learners* that forms around YouTube content. A strong hint of strategy here (we may well have adopted a strategy that joins our learners with others around the continent or

around the world), but Duffy is actually talking specifically about the *education benefits* that might accrue from the use of YouTube.

Tracking the flow of knowledge through education, and understanding the benefits

This directs our attention to an extremely important consideration: a technology cannot simply be "used" in education without it being embodied in an **education system** that renders it useable: a *personal computer* (technology) needs a *browser* (system) before *the internet* (technology) can be used to deliver YouTube content; in the general case, a *data projector* (technology) needs a *PC* (technology) with a *presentation suite* such as PowerPoint (system) installed in order to present generic learning material. In all cases, of course, we also need a *capable user* who understands how to use the browser, YouTube or the presentation suite, and human capability becomes a necessary part of the full "education system" if it is to work. The education literature tends not to highlight the idea of *information systems* as such frequently, but their importance (and the differences between different kinds of system) is evident:

> *" … complexity arises when some **systems** are integrated into relatively concrete activities such as admissions processes or timetabling, whilst others such as the **learning** process cannot be described in these terms." (Hardman and Paucar-Caceres 2010:169)*

Hardman and Paucar-Caceres are discussing the tangible and intangible aspects systems, and the need to measure the intangible as well as the tangible benefits, even if reducing the idea of benefit to some form of quantification. This example therefore supports both ideas: that the reference model must incorporate **education system** and also **education benefit**. The fact that both concepts are not frequently found in the academic literature does not mean that they are not important – they are both critical to the full understanding that is necessary for good management.

We can now extend the core of our straw model to incorporate these ideas:

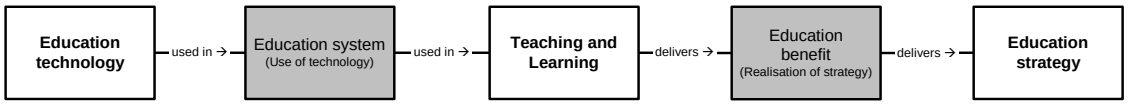


Figure 10: Introducing the concepts of education systems and education benefits

We are not done. These two new concepts are both important for other reasons. An education system is concerned to render knowledge into the teaching and learning process, and education benefits are only really evident when newly gained knowledge is deployed:

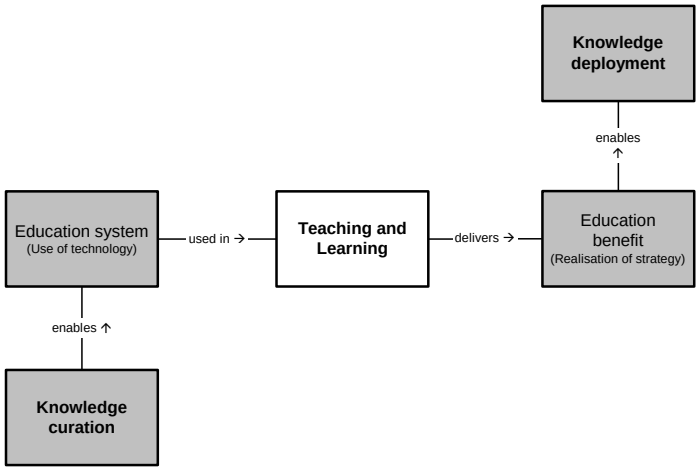


Figure 11: Tracking the flow of knowledge through education

There is adequate evidence in the literature about the importance of knowledge management.

Bhusry and Ranjan undertake an interesting discussion about the importance of knowledge management in education:

> *"**Knowledge** produced in the process of course preparation and delivery* [**i.e. teaching and learning**] *is colossal and it is required that collaborative effort is pooled in to maintain this knowledge as an institutional resource* [**i.e. knowledge curation**]*." (Bhusry and Ranjan 2012:314)*

They develop their own framework, relating information technology to knowledge management:

> *"This can be explained in terms of the potential of IT infrastructure in facilitating KM processes by providing a platform for **knowledge acquisition**, **storage** and **dissemination**, supporting collaboration among stakeholders and fostering centered, real time, integrated systems." (Bhusry and Ranjan 2012:327)*

The reader is particularly recommended to look at Boyle's Figure 1 – the framework that is referred to here – it is a process model, not a reference model, but it reinforces many of the ideas that are emerging here.

Boyle and colleagues discuss the importance of *people* in dealing with international education:

> *"We highlight why the tacit dimensions of the **knowledge** transferred during international education provision makes it difficult to provide educational services in offshore campuses, without the transfer of people." (Boyle et al 2012:303)*

At the same time that we add these four new ideas to the model, we can make one other important move, which requires a digression.

Resolving many-to-many relationships

We have to deal with the issues of multiplicity, where a relationship between two entities shows that *many* (at the one end) relate to *many* (at the other). This is because *many-to-many* relationships generally hide something else that is yet to be recognised - something that relates *one instance* on the one side to *one instance* on the other. Consider that an **education system** will serve *many* different **teaching and learning** needs, and that any instance of **teaching and learning** may employ *many* different **education systems**:

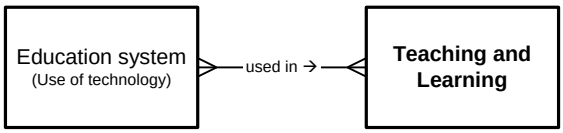
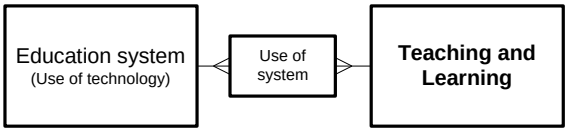


Figure 12: Developing the reference model: showing cardinalities

The "crow's feet" indicate that we have *multiplicity*, on both sides, in both cases. The next move is therefore to introduce an idea that resolves the problem. We can define "*use of system*" thus:

- **Use of system:** Indicates a single instance of a specific education system being used in a single specific instance of teaching and learning.

This provides a *one-to-many* relationship on one side, and a *many-to-one* relationship on the other[7]; it resolves our difficulties and reveals that the act of *usage* is central to our understanding:



[7] These low-level entities that resolve many-to-many relationships are sometimes known as *associative entities*, because they associate one higher-level entity with another.

Figure 13: Developing the reference model: adding resolving associative entitites

In fact, in many places in the model we have multiplicity, and we must take this in two stages. First, the model *before* resolution of the many-to-many cases:

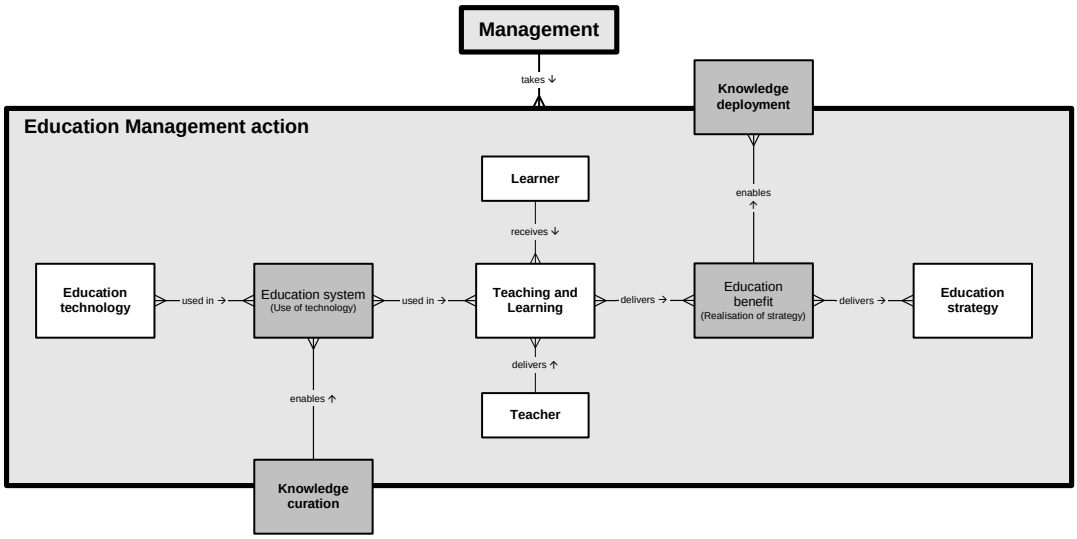


Figure 14: The essential components of the reference model – introducing cardinalities

Each of the four relationships along the chain of value show many-to-many. We deal with all of them in a similar way:

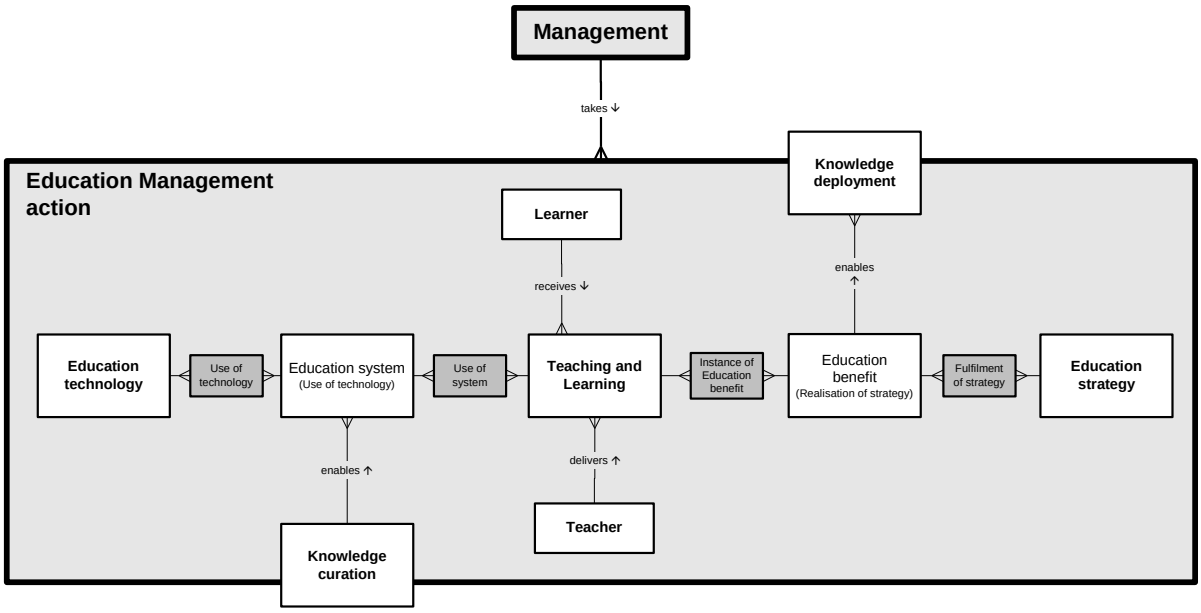


Figure 15: Developing the model: many-to-many relationships resolved

It is not difficult to find references to the use of technology and systems in the literature. In an analysis of young people's motives for interactive media use, Van den Beemt, Akkerman and Simons pay detailed attention to the societal context within which young people live and learn, with examples:

> *"These examples describe how contemporary youth seem to **use** the social and cultural functions of interactive media to find a way in, and give meaning to their social environment." (van den Beemt et al 2011:60)*

Fanni and her colleagues offer a discussion about the different research methods that might be chosen to measure the value of different approaches to e-learning:

> *"Whilst [it is] acknowledged that quantitative measurement is a powerful tool, this research demonstrates the **value** of blended methodologies. Qualitative analysis not only assists with the interpretation of quantitative data, but also suggests new perspectives with which to deepen quantitative analysis." (Fanni et al 2011:12)*

Stoltenkamp and Kasuto are similarly concerned with the value that might be found from the use of e-learning tools:

> *"… eLearning implementation does not only encompass the delivery of training programmes, but in this case it was necessary to embark on a campaign that would familiarise educators about … eTools and their **pedagogical value**." (Stoltenkamp and Kasuto 2009:50)*

And so we can easily find adequate evidence that the ideas of *usage*, *value* and *fulfilment* need to be incorporated in the model, and – conveniently – they resolve our concern about many-to-many relationships.

This is important because for an education manager, decisions about the use of education technologies, systems, can only be fully informed when representative instances of the *use of technologies* and the *use of systems* are counted and measured, across all technologies, all systems and all teaching and learning. Because of its potentially broad application, a decision about acquiring information technology for education can only be fully supported when the potential of that technology *across all subjects*, and its use in *all relevant systems*, is understood. An educational institution that does not recognise and manage *systems*, and does not negotiate and agree to *benefits*, will never take the best investment decisions.

At this point we have introduced to the reference model all the points at which "many" instances of an entity might relate to the other (or others); we have also introduced the important idea that **knowledge** must flow through the education system. On the one side, where it becomes some kind of learning material embodied in an education system, we refer to **knowledge curation**; on the other, where education allows newly gained knowledge to be used in work and in life generally, we have **knowledge deployment**. This captures the important ideas seen in the working version of the reference model shown previously: *knowledge creation and acquisition* and *knowledge delivery and dissemination*. We can see the upper part of the developing model as the area of *demand* (for education) and the lower part of the model as the area of supply (of what we need to provide education). At the same time, dealing with the *many-to-many* relationships has introduced four very useful associative entities that will typically prove to be the hot-spots in managing technology in education, and where detailed transactional data will need to be gathered if we need to get a very good grip on the management issues.

Of course, this is all somewhat idealistic, and it is only part of the story, but let us not get bogged down in the details at this stage. There are two more things to do: the model must be further extended to accommodate the idea of external *stakeholders*, and it must be used to show where good management (and good research) will need to be careful with *typologies*.

Adding outcomes and stakeholders, and closing the inner loop

The review of the literature has revealed many different kinds of stakeholders: teachers and learners (obviously), managers, policy makers, parents, local communities, suppliers and yet others. It was decided not to try and represent every kind of stakeholder specifically in the model because it would become too complex. We already have **Management**, a suitable proxy for "managers" at this stage, and the role of ICT suppliers is found to be important (whether commercial supply organisations such as Mecer and Apple, or governmental supply agencies such as the provinces) and so ICT suppliers are included specifically. In order to deal with all others, a generic concept of **Stakeholder group** has been included. This is important, because management research has shown

very clearly (Parasuraman et al., 1985) that it is the *perceptions* of stakeholders as well as the *actual performance* of an organisation that needs to be measured and managed. This is represented here by **actual outcome** and **perceived outcome**:

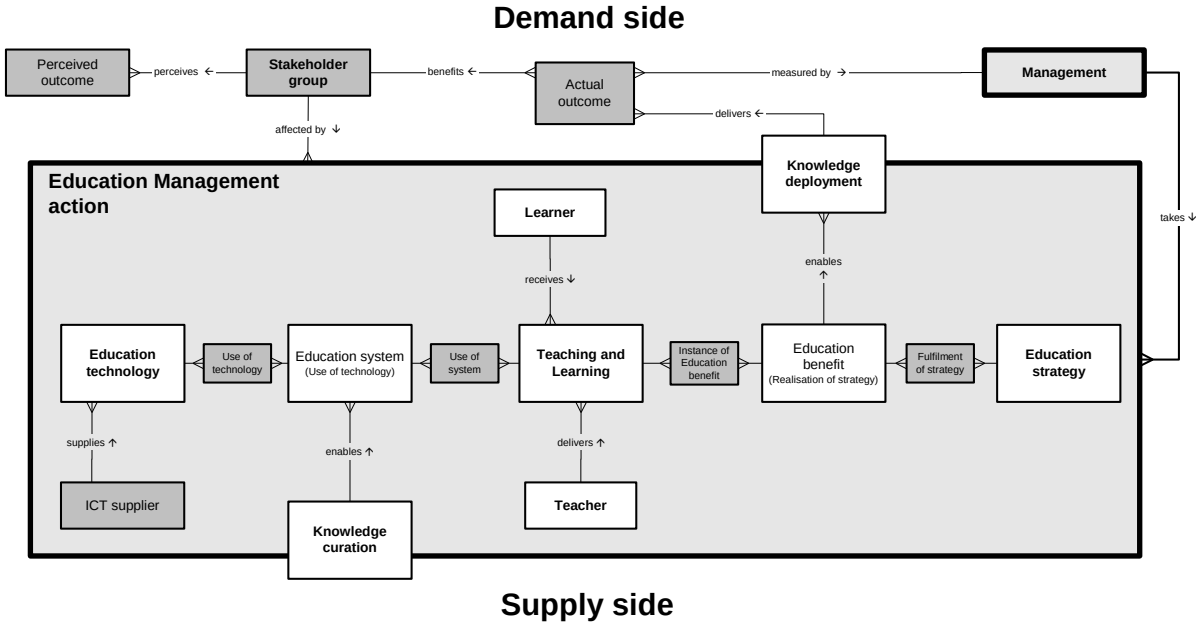


Figure 16: Demand, supply and outcomes – resolving cardinalities

The reference model is now labelled with "Demand" issues at the top, and "Supply" issues at the bottom[8]. It also has the essential elements of a virtuous circle of management: the achieved educational benefits lead to successful education, the deployment of knowledge, significant and actual "real world" outcomes, providing a basis for performance measurement that tells management the extent of what has been achieved, and what further actions to take. This can be seen as the "inner loop" of management activity, which in a competent management regime will lead to results that can be communicated to stakeholders and others. In the sense that *demand* derives largely from stakeholders, it is therefore important to make sure that they can see that what has been delivered meets that demand.

Stakeholder groups of different kinds really do occur in the literature. Parents are a common group, not always well managed:

> *In all schools the importance of conferences was trivialised due to the inadequate time allotted to interactions, which hardly allow true dialogue. Unequal power relations between parent and teacher* [**i.e. stakeholders**] *were emphasised bythe poor seating arrangements and venues that lacked privacy. (Lemmer 2012:93)*

Governors also face difficulties in many South African schools:

> *"It is clear from the participants' responses that there are difficulties in understanding governance, mainly because governors* [**i.e. stakeholders**] *perceive their roles differently, which detracts from their main responsibility — promoting the best interests of the school. This, combined with less than adequate capacity-building as required by the Schools Act, adds to the ineffective execution of functions." (Xaba 2011:9)*

It is easy to find literature that ranges easily over many of the entities that we have in view, including supply organisations with other primary stakeholders, technologies and systems:

[8] This is in sympathy with the "Gap model" promoted by Parasuraman, Berry and Zeithml in their original Service Management work, that has inspired so much other management thinking in the many years since.

> *Since 1993, the implementation of the 'Enlaces' educational network* [**i.e. supplier**] *has provided training approximately 110,000 teachers* [**i.e. stakeholders**]*, has reached more than 90% of secondary and primary schools (covering more than 96% of the student* [**i.e. stakeholder**] *population attending state-subsidized institutions), has supplied close to 110,000 computers* [**i.e. technologies**] *to schools, as well as educational software* [**i.e. education systems**] *to support their study programs* [**i.e. teaching and learning**]*." Blignaut et al (2010:1556)*

But we are now aware that there are many different kinds of stakeholder, and technology, and system … it is time to acknowledge that these central features of education and education management must be understood and organised as typologies.

Adding typologies

The central elements of the reference model are all subject to variation. Teachers might be old or young; learners might be motivated or not; technology might be simple or complex; strategies could be aggressive or passive … and so on. It is worrying that much research is undertaken without regard to the important differences that exist. Consider for example the following excerpt from a research report that examined the impact of educational beliefs on the classroom use of computers in primary schools:

> *" … a questionnaire was administered to a sample of 525 primary school teachers from 68 schools in Flanders (the Dutch-speaking area of Belgium). The participants were distributed evenly across all primary schools grades. Of the respondents, 81% were female and 19% were male. Ages ranged from 22 to 64 years old". (Hermans, 2008:1502)*

We have some consideration of variations in teachers according to the *school* they work in, the *grades* they teach, their *gender* and their *age*. There seems to be no consideration of their training, their experience (even in terms of the number of years they have been teaching), their motivation, their personal circumstances and their commitment to their work. Any of these factors could be far more significant than age or gender.

Consider the technologies. Cox and Marshall came head-to-head with the differences that exist:

> *"Various government surveys have shown that **teachers**' **ICT uses** are usually confined to very few types, e.g. using an **interactive whiteboard** for whole class demonstrations or using **word-processing** for creative writing … different types of **ICT resources** will have different effects on **students**' learning, for example, using science simulations to correct students' misconceptions … using **data handling software** to improve students' abilities to apply binary logic … using **word-processing in English** to reduce punctuation and grammatical mistakes … It is clear that from these and numerous other examples that the contribution of **ICT** to **students' learning** was very dependent upon **the type of ICT resource** and **the subject** in which is was being used." (Cox and Marshall 2007:53)*

The need to understand and capture these (and all the other) differences is true to some extent or another for all the primary entities. As can be seen, in Figure 17 (below) 10 such typologies have been added. In one sense this is actually optional – it is not necessary to explicitly show what is always true: that all the primary entities in these cases will be candidates for a typology. But the lazy treatment of differences that is found in typical education research, and in education management, suggests that regular reminders are needed.

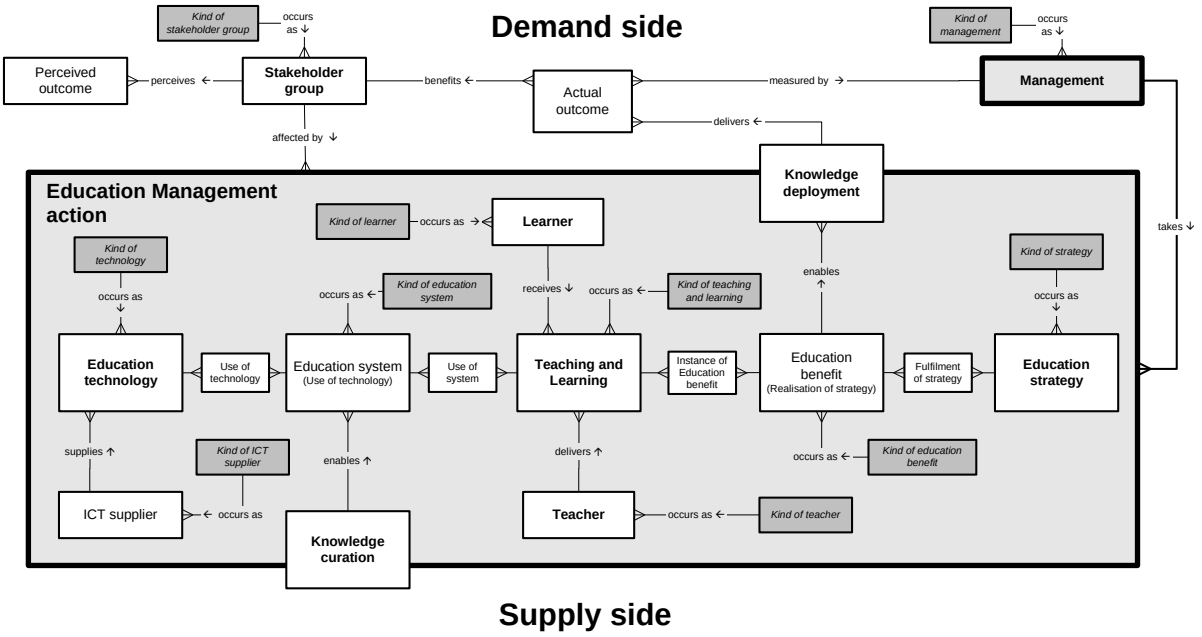


Figure 17: Introducing typologies

Closing the outer loop

There is one more thing to do. This report emanates from a *research project*, and research is a sometimes-forgotten aspect of education.

It is possible to add research to the reference model in a way that shows how the outcomes of education can be studied, analysed, reported and published, providing important input to the design and delivery of education and to the furtherance of educational strategic thinking. A great deal more detail could be added here ("Kind of publication" and "Kind of research" come to mind!) but better to keep this side of things simple.

The final form of the reference model follows with these details. It now has an "outer loop" of research that tracks educational performance, informs about the deeper and longer-term aspects of managing ICTs (or anything else that we choose) in education. This report stands as one example of this outer loop.

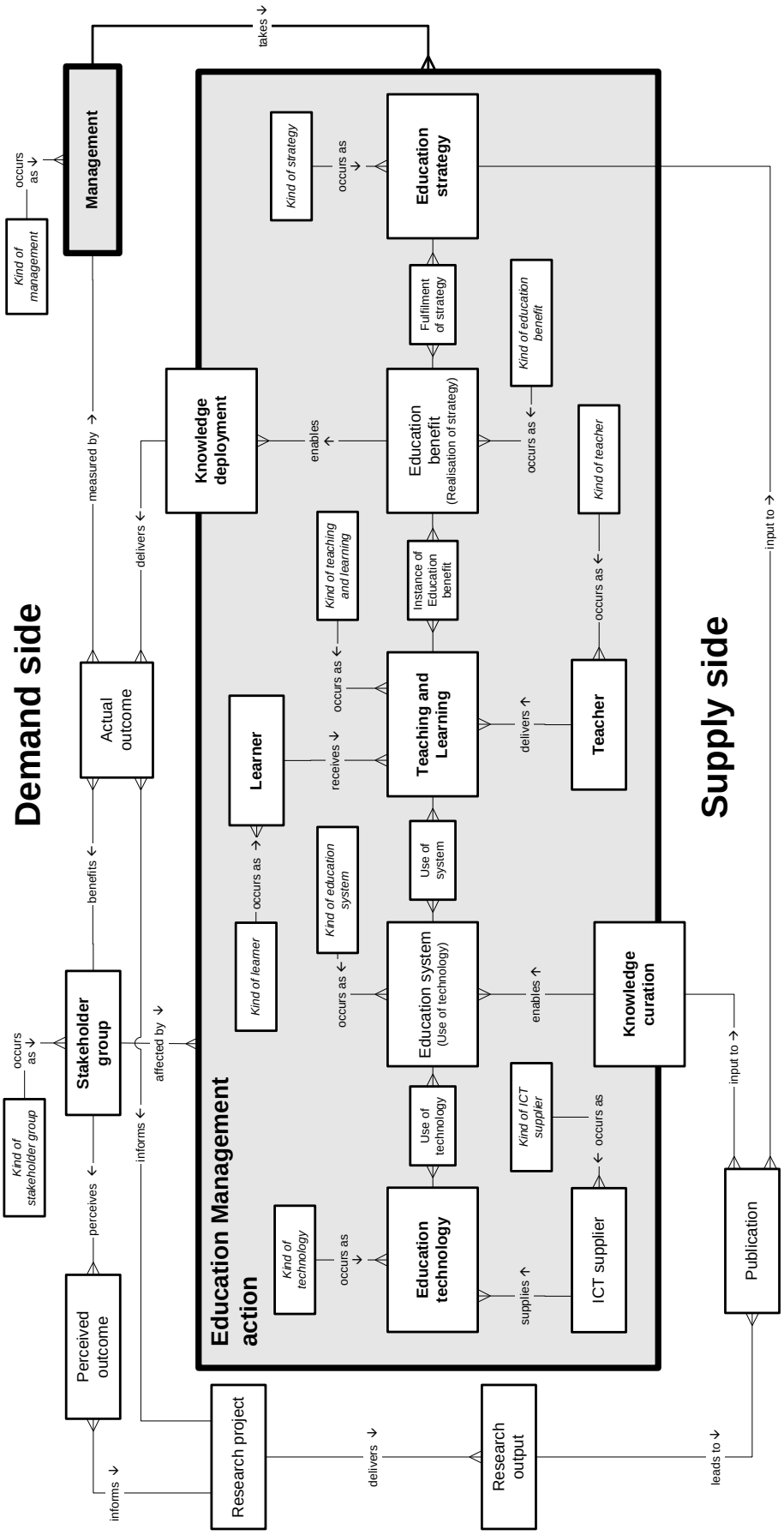


Figure 18: The final reference model

A summary of some of the evidence that supports the Reference Model

The literature that has been reviewed provides extensive evidence of some of the components of the Reference Model, but only limited evidence of others. The table that follows lists some of the articles that elucidate the key components of the model.

Stakeholder There are many references to "stakeholder", and occasional identification of stakeholder types, but much more work needs to be done here. The word seems to be used quite loosely without serious attention to the actual stakeholder groups that are under consideration.	(Downes 1999:336) (Hardman & Paucar-Caceres 2010:180) (Lemmer 2012:94) (Tubin et al 2003:134) (Xaba 2011:9)
Management Almost no work is found dealing with the *management* of educational technology at the institutional level. It seems to be taken for granted except in limited cases, for example in the case of school governing bodies (where Xaba goes into good detail and Bialobrzeska and Cohen, who have written a complete guide for school principals).	(Bialobrzeska and Cohen 2005:97) (Banker et al 2011:501) (Bytheway et al 2012:116) (Czerniewicz and Brown 2009:130) (Gudmundsdottir 2010:182) (Hardman & Paucar-Caceres 2010:180) (Parker 2010:259) (Stoltenkamp & Kasuto 2009:46-49) (Vanderlinde et al 2012:517) (Xaba 2011:9)
ICT supplier There are many reference to "resources" but virtually none to "sources", and few to specific kinds of supply, for example donor equipment, provincial government initiatives. Cook and Light touch on the "Internet of things" (IoT, about which we will no doubt hear a great deal more, quite soon).	(Cook and Light 2006:59) (Duffy 2007:182)
Education technology Many very specific references to specific technologies, for example interactive whiteboards. Very little reference to web services (such as Google, Dropbox and tablets).	(Bytheway et al 2012:116) (Czerniewicz 2004:150) (Czerniewicz et al 2006:8) (Ferreira 2010:25) (Gachago et al 2013:12) (Gülbahar 2007:956) (Keats 2009:50) (Parker 2010:255) (Singh 2008:1063) (Slay et al 2008:1330) (Straub 2009:645) (Wasko et al 2011:652) (Watson 2006:214) (Wong and Li 2008:114)
Education system Very little is found that is explicitly about the information systems that actually work to support teaching and learning (and administrative) activities.	(Parker 2010:259) (Wong and Li 2008:115)
Teaching and Learning There are copious references to teaching and	(Balanskat et al 2006:3) (Bialobrzeska and Cohen 2005:96)

learning.	(Chigona et al 2010:30) (Churchill 2006:495) (Cook and Light 2006:59) (Czerniewicz and Brown 2009:130) (Frantz et al 2011:17) (Gachago et al 2013:12) (Gudmundsdottir 2010:176) (Hart 2007:44) (Howie & Blignaut 2009:361) (Lim and Chai 2008:808) (Ogbonnaya 2010:10) (Ortega & Bravo 2002:2) (Rossouw 2009:13) (Singh 2008:1063) (Slay et al 2008:1328) (Stoltenkamp and Kasuto 2009:53) (Vanderlinde et al 2012:508) (Wolhuter et al 2012:178) (Wong and Li 2008:115)
Education benefit There are limited and often oblique references to the benefits and advantages of technology and systems in education.	(McClea and Yen 2005:93) (Ogbonnaya 2010:10) (Slay et al 2008:1330) (Wong and Li 2008:114)
Education strategy Extensive detail alluding to strategy but surprisingly little attention to the real strategic issues: how strategy should be formulated, and the challenges of implementation.	(Stoltenkamp & Kasuto 2009:46-49) (Wong and Li 2008:115)
Learner Copious references to learners, as would be expected.	(Bialobrzeska and Cohen 2005:97) (Davidson and Desjardins 2011:61) (Duffy 2007:182) (Frantz et al 2011:17) (Gachago et al 2013:12) (Gudmundsdottir 2010:176) (Hart 2007:44) (Howie and Blignaut 2009:361) (Lemmer 2012:94) (Rossouw 2009:13) (Tubin et al 2003:134)
Teacher Copious references to teachers, as would be expected.	(Chigona et al 2010:30) (Churchill 2006:495) (Cox and Marshall 2007:68 (Davidson and Desjardins 2011:61) (Gudmundsdottir 2010:182) (Gülbahar 2007:956) (Lemmer 2012:94) (Ogbonnaya 2010:10) (Slay et al 2008:1328) (Slay et al 2008:1330) (Straub 2009:645) (Straub 2009:645) (Tubin et al 2003:134) (Vanderlinde et al 2012:517) (Wedman and Diggs 2001:429) (Wolhuter et al 2012:178) (Wong and Li 2008:115)

Real world benefit It is difficult to find examples of research that has looked at the longer term benefits to society (and industry, and government, and communities) that might derive from information technology and information systems. Even the SITES study by Blignaut et al makes no reference to the wider benefits of ICTs in education.	(Keats 2009:50)
Knowledge deployment Adequate appreciation of the fact that this is a great deal to do with knowledge management, but …	(Boyle et al 2012:312) (Churchill 2006:495) (Duffy 2007:182) (Lemmer 2012:94) (McClea and Yen 2005:93) (Singh 2008:1063) (Wedman and Diggs 2001:429) (Wong and Li 2008:115)
Knowledge curation … very little about the educational processes that originate new knowledge. Plenty of urging for more research to be done, none on the contribution of technology to research itself, as another educational process.	(Balanskat et al 2006:3) (Cox and Marshall 2007:68) (Czerniewicz et al 2006:8) (Downes 1999:336) (Ferreira 2010:25) (Frantz et al 2011:17) (Gachago et al 2013:12) (Gudmundsdottir 2010:176) (Hart 2007:44) (Mutula 2009:10) (Roman and Colle 2003:88) (Wasko et al 2011:652) (Wolhuter 2011:612)

Assessment of the reference model against requirements

The reference model was intended to achieve six things, as listed and assessed below.

- To be able to identify areas where ICTs may have application.

The means to organise information about the *application* of ICTs is clear: the technologies, the systems that render them usable, and the teaching and learning that needs those systems can all be organised according to the model, and the differences within each can be logged and analysed. However, it was not the intention of this study to catalogue all technologies, systems and teaching and learning activities, that is already done elsewhere and of course things change quickly. The reference model provided here is timeless, and independent of the shifting sands of technology and education over time. Indeed, it provides a sound framework with which to measure, tabulate, analyse and compare the performance of education management over time.

- To map teaching and learning processes to progression of education (the two principal perspectives)

This detail is embedded within the single entity “Teaching and learning”. Further work can drill down and expose the detail of education processes and activities, and the way that grades develop learner knowledge, but the literature that was found (and the other sources that were available) did not provide the evidence that is needed for a reliable mapping of educational activity to learning level, and to technology. This is work that could still very usefully be done.

- To review and assess the potential of ICTs in education

The research team already had considerable previous experience concerning the potential for ICTs in education (and some of the problems in achieving it), and this study has confirmed what we all perhaps already know: there is huge potential yet to be revealed, the nature of education is changing dramatically as technology evolves, and things will continue to change. However, the human factor is of primary importance. There is considerable evidence of difficulty, disappointment and a loss of confidence. This derives from the depth and extent of the changes that we face (when seen on a global scale). Hence, the need to manage education strategically is paramount. The study has found endless passing reference to strategic issues but little recognition that strategic management is needed to deal with them.

- To locate the potential application domains

The reported work that we have been able to study provides little evidence of any limitations to the potential. There is too much research that is very finely focused – on one school, or one subject, or one technology, for example – that it is difficult to take a holistic view. The early presumption that mathematics would be an obviously interesting domain is only partly vindicated and the evidence that ICTs in education makes no real difference is worrying. Most of the potential seems to exist at the level of the globalisation of education resources (why does any teacher need to prepare new material when it all exists?) and of educational delivery (those who are fortunate enough to have internet access, and sometimes the required funds for registration, have a vast range of curriculum options to choose from).

- To allow the development of a portfolio view of present and future opportunities

All that is needed to establish a portfolio of education technology, systems and practices (and their benefits and outcomes) is provided in the model. It immediately provides a coherent framework within which an institution can inventory their technology, systems, practices, intended benefits and strategies; it allows for the identification of key partners and their expectations, as stakeholders. More detail can be added, perhaps some detail could be discarded, and the words and phrases that are used can be amended to suit a particular situation. The reference model now needs to be deployed in further research, that will hopefully lead to better and more comparable results, and that will lead to better real-world outcomes.

- To populate the model with empirical data

The restricted funding did not allow the additional work that would have been necessary to populate the model with data. However, at the time of writing it is planned to continue to do exactly that in a specific follow-up (personal) study.

Appendix 3: The Flash MOOC

Introductory comments

The MOOC ("Massive Open Online Course") is an interesting example of something that few people anticipated, and that many people scoffed at when it first happened. Yet, the MOOC phenomenon reflects many features of the "social web", that allows communities (and sub-communities) to form and un-form in short periods of time. It eliminates problems of time and distance, but this is an old debate and we do not need to dwell upon that aspect of it here. What is important here is that many MOOC implementations have been undertaken on traditional academic timescales, but participants live in a hectic technology-oriented world where things happen very quickly. Hence, many early experiences with MOOCs tell us that the dropout rate will be very high.

Typically, the core idea of a MOOC is based on a famous name, or a contentious idea. It will offer a collation of relevant learning resources, from all available sources, to a distant audience, within an organised and shared structure that assists participants to deal with the very high volumes of messaging that emerge. Clearly, this approach to education is challenging the way we think about teaching, learning *and* about examinations. There is generally no certificate or diploma on completion of a MOOC, but assessment at the conclusion of online, distance education is a rapidly developing field with commercial rewards for those who manage to provide it in a secure and accessible manner. Peer assessment is one way of knowing when you are in your "learning", but this could change.

Will the MOOC really shift the paradigm of conventional education? Probably, but in an incremental way. Do we understand how to manage MOOCs? No, not yet. Those who are blazing this new trail are a small minority and there are many lessons yet to be learned about how people might react and how they might be impacted. Managing people is, of course, a universal issue in education. So, who are the people we are dealing with? What are their needs and their expectations? It is impossible to understand tens of thousands of registered participants, but social forces will persuade groups to form, and groups will have the chance to develop a consensus about who they are, what they need and what they hope for.

The Flash MOOC at CPUT

This experimental exercise combined the idea of a "flash meeting" (impulsive, organised using social media, open to all, brief and often somewhat mischievous!) with learning at a distance. Because dropout rates have been found to be very high, there is an argument that a short but intensive course, well organised, and well supported by web services such as Google, Wordpress and ResearchGate, would attract a good audience and provide an intensive learning opportunity.

The design

The Flash MOOC was designed to last for eight hours, and considerable effort was put into its design and implementation. Multiple channels were used to promote the opportunity, a Saturday was chosen as the day for delivery, and themes were devised and supported with expert opinion, pre-recorded videos, and suggested reading. The main and subsidiary themes echoed the main perspectives already inherent in this research, as follows:

- Management perspective
- Stakeholders
- Strategy
- Planning
- Portfolio management

- Technology perspective
- Classroom workstation
- Telecommunications infrastructure
- Technology for research
- Cloud tools
- Education perspective
- Education interfaces
- Digital Blooms taxonomy
- Didactics and pedagogy
- African relevance
- African societies
- Learning and learners in Africa
- Technology adoption in Africa
- African cultures and e-learning
- Teaching the teachers
- Implementation approaches
- Ecosystem approach
- People
- Processes
- Technology

A detailed discussion of the results of the Flash MOOC must be undertaken elsewhere, but the principal findings are discussed below. The comments that are made, and the charts of participant activity, are based on a detailed coding and analysis of the complete transcript of the eight hours of the MOOC, focusing on the first three main topics (management, education and technology) and rolling other issues into a fourth topic referred to as "context". It is a *first* analysis, and the opportunity to continue digging deeper into the data is available to others.

We built it, and they came

More than 80 people registered for the course. Hardly "massive", but adequate in order to observe and note the patterns of behaviour. Of the 80, almost 40 were *active* participants, which was disappointing but perhaps inevitable. Some of the participants were undergraduate students with little confidence to launch and defend public arguments.

Analysis

The charts that follow, with some discussion and explanation, provide a first insight into the form and substance of the day. They are followed by some limited examples of the discussions of the day. Some summary statistics are as follows:

18 Topics were analysed, within which there were 10,827 words, comprising a total of 453 contributions with an average of 24 words each.

The analysis (an *open coding* exercise) developed 2207 codings of 99 categories, as reported in the charts that follow.

Participation

Of all those that registered for the course, 37 registrants participated actively. However, it can be seen that six participants only posted one contribution, where as a group of eight highly-active participants contributed about 20 or more times.

The greatest number of contributions from an individual was 44 (Participant 28).

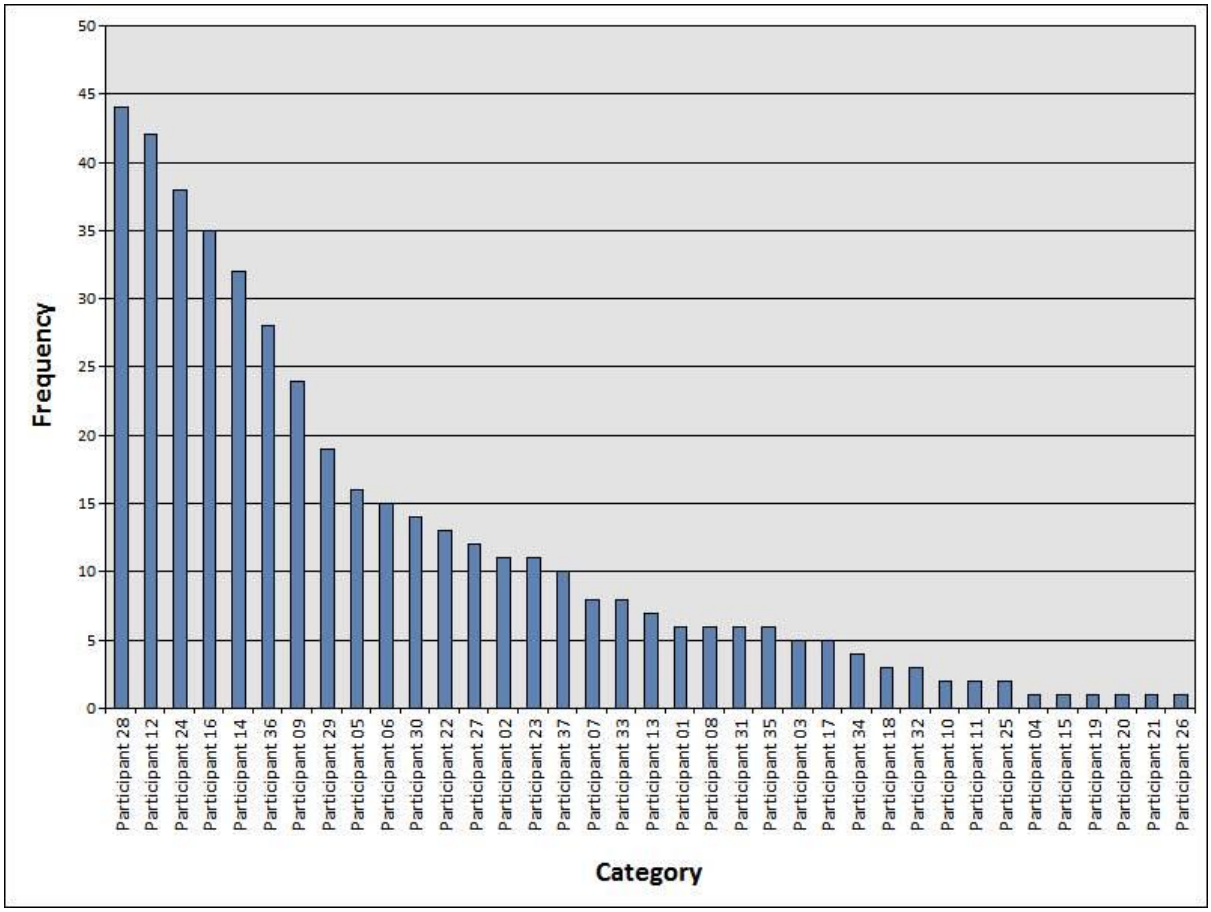


Figure 19: Participation

This kind of distribution is no doubt to be expected.

For those readers who have never seen simple teaching and learning analytics, the ease with which activity can be tracked and individual performance can be monitored (when working online) becomes clear.

The nature of the discourse

Of course, individual contributions were of quite different kinds. The greatest number were only classifiable as "comments", in that they proffered no question, not answer and no information in terms of references to interesting external sources. This intention – to solicit and gather external references – was one of the primary objectives of the Flash MOOC; any researchers concerned with the subjects under discussion would naturally benefit greatly if a "body of literature" could be collected, at the level of references for later retrieval and study. In the event there were 69 references provided by participants. At the time of writing they have not yet been investigated.

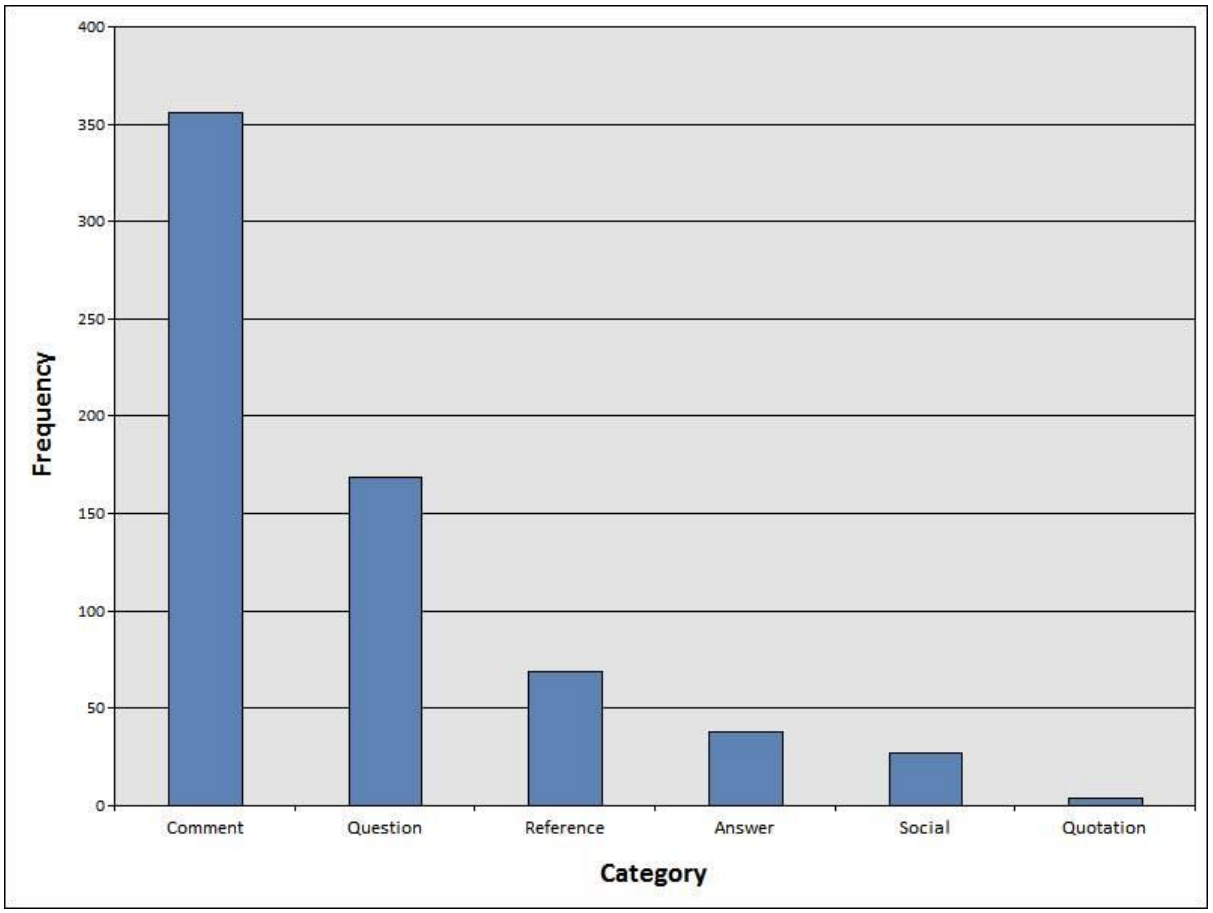


Figure 20: Nature of the discourse

It can be seen that there were about 27 contributions that were entirely social. A typical example:

> *"Looking forward to participating. My internet connection is dead slow this morning… but hey… this is one part of the problem in SA - lack of vision and delivery" (Participant 09)*

There were just four contributions that comprised quotations from other peoples comments, or from other sources.

Analysis of all categories

As indicated, the analysis of the Flash MOOC narrative was undertaken as an open coding exercise. This means that as the contributions were studied, significant ideas or concepts that were evident were collected and used to gather further evidence, from other contributions. This is a fairly high-risk exercise *unless it can be verified by parallel coding by independent coders*, that has not yet been done in the present case but the opportunity still exists to do so.

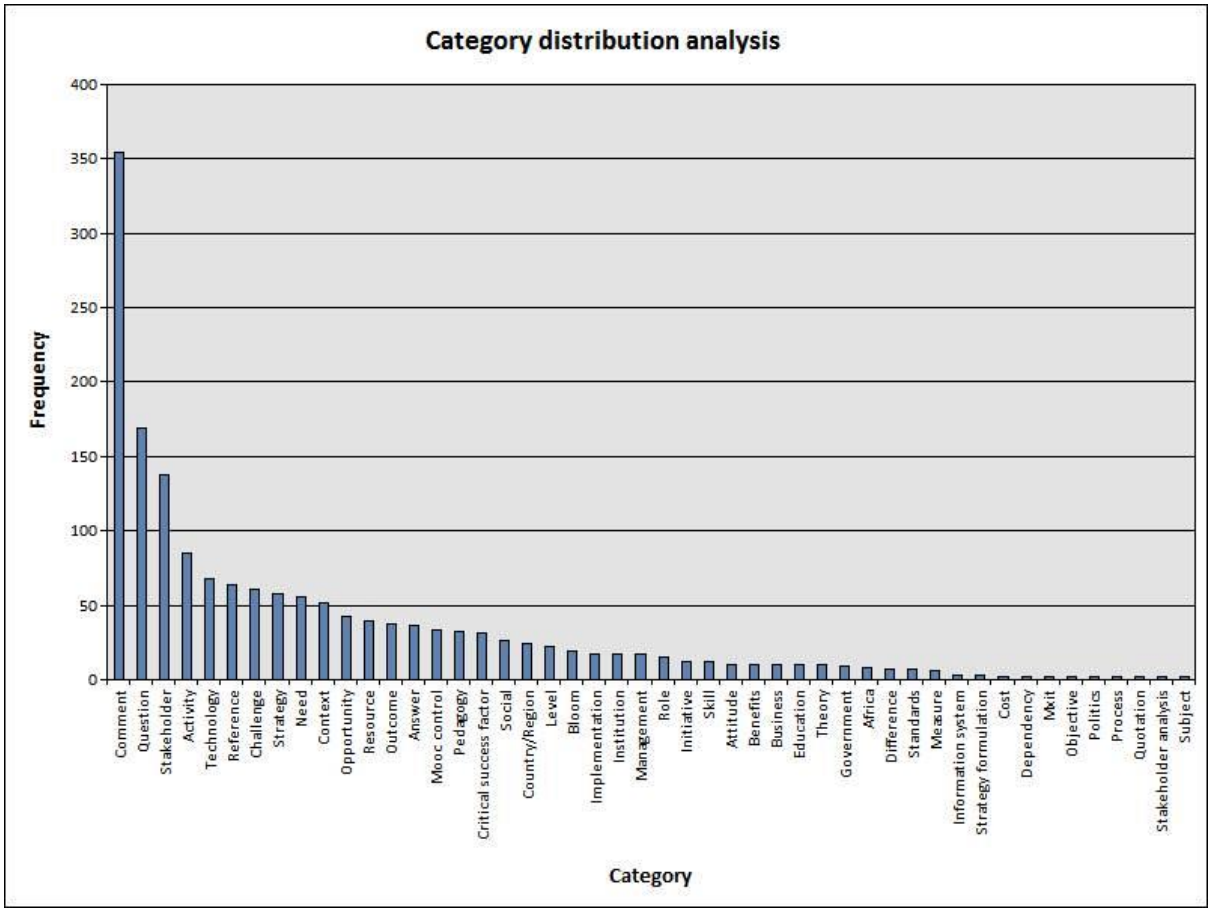


Figure 21: Analysis of all categories

It has already been noted that there were just more than n350 "comments" – the most frequent single category in the coding, by far. This is a disappointment, because the quality and benefit of involvement would rather be found in questions and answers, rather than in loosely connected (or even disconnected) comments with no continuing "golden thread" to the discussion. There were many more questions (169) than answers (38). However, it can be seen that there are some topics that recurred relatively frequently, for example:

- Stakeholder
- Activity
- Technology
- Challenge
- Strategy
- Need and context

And so on. What is more useful that pouring over *all* the categories is to group them into the key topic areas.

Analysis of the main topics

There were five discussion areas (see the early comments in this section) but for the purposes of this analysis they were combined to include the three principal topics in the study, and everything else in "context":

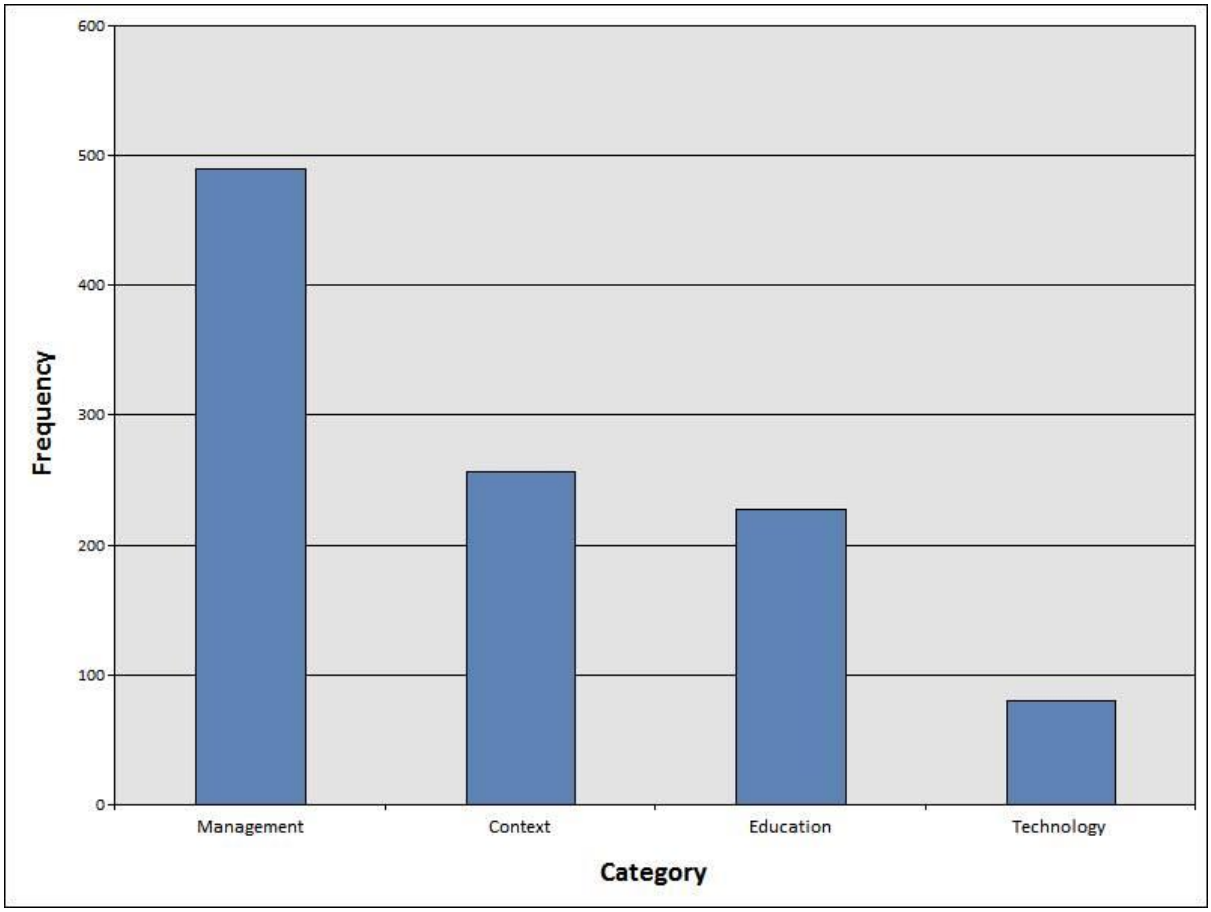


Figure 22: Analysis of the main topics

The frequency of reference to issues that could be coded as "management" is very encouraging, and it suggests that there is indeed a high level of interest in managing ICTs in South African education. Most of the participants (and especially the ones most active in the discussions) were from an education background, and it is therefore to be expected that there would be extensive comments about education issues; what is disappointing is the low level of reference to technology itself. The extent to which educators (and learners) *should* be directly interested in technology emerges, and could be the subject of further investigation.

As already explained, the "context" category was used as a catch-all, and there is more detail about that in the final chart in this series.

Technology: Supply-side issues

The analysis indicates that there were 80 contributions concerning technology, but most of them were not specific to a particular technology or technology-related issue. It would be useful to pass through the data again, to try and tie down the points that were being made.

Those that were specific were few (only nine), and are charted below:

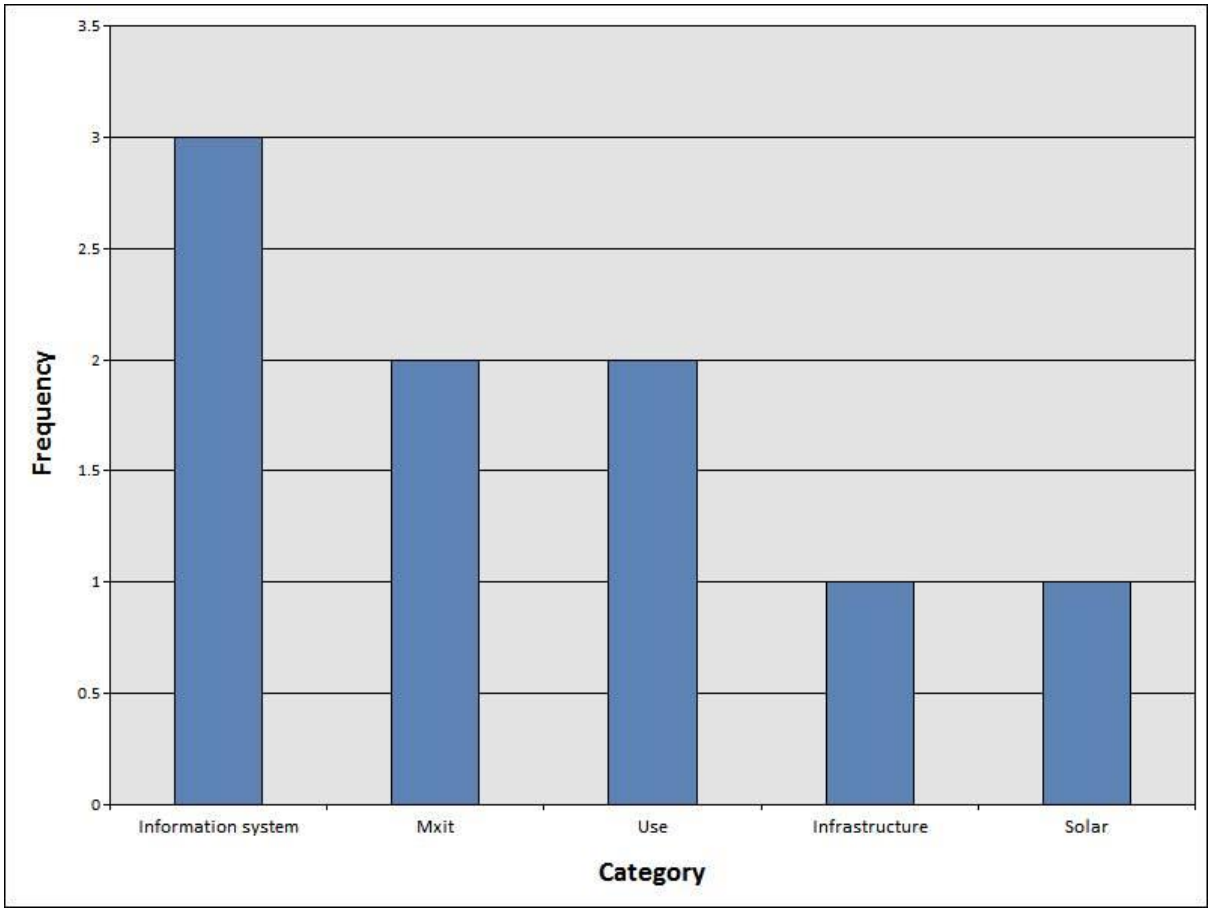


Figure 23: Supply-side issues

This is still interesting, of course. We see very little recognition of the importance of "information systems". Is the research project team deluding itself, in arguing that the recognition of the importance of information systems is paramount? After all, the introduction of a new *system*, for supporting learning through a Learning Management System, or just for marks administration, or for laboratory measurements, is the very unit of investment that needs planning, costing, justification and implementation. Here is a comment about the administrative system that registers students at CPUT:

> *Take for example the current **system of registration** obtainable in CPUT, which demonstrates a high level of chaos, distress, and inconvenience for the students, an experience which shouldn't be witnessed at an educational level of higher learning, especially when considering that it is a school of technology. (Participant 18)*

But this is not the place to delve into the detailed arguments, especially about the quality of administration in one particular institution. We can glance at these results briefly, agree that more work is needed, and move on.

Education: Demand side issues

In the discussions about education specifically, there is a natural tendency to talk about what we do, and how we do it. Here such contributions are coded as discussions about "activity", and they are predominant.

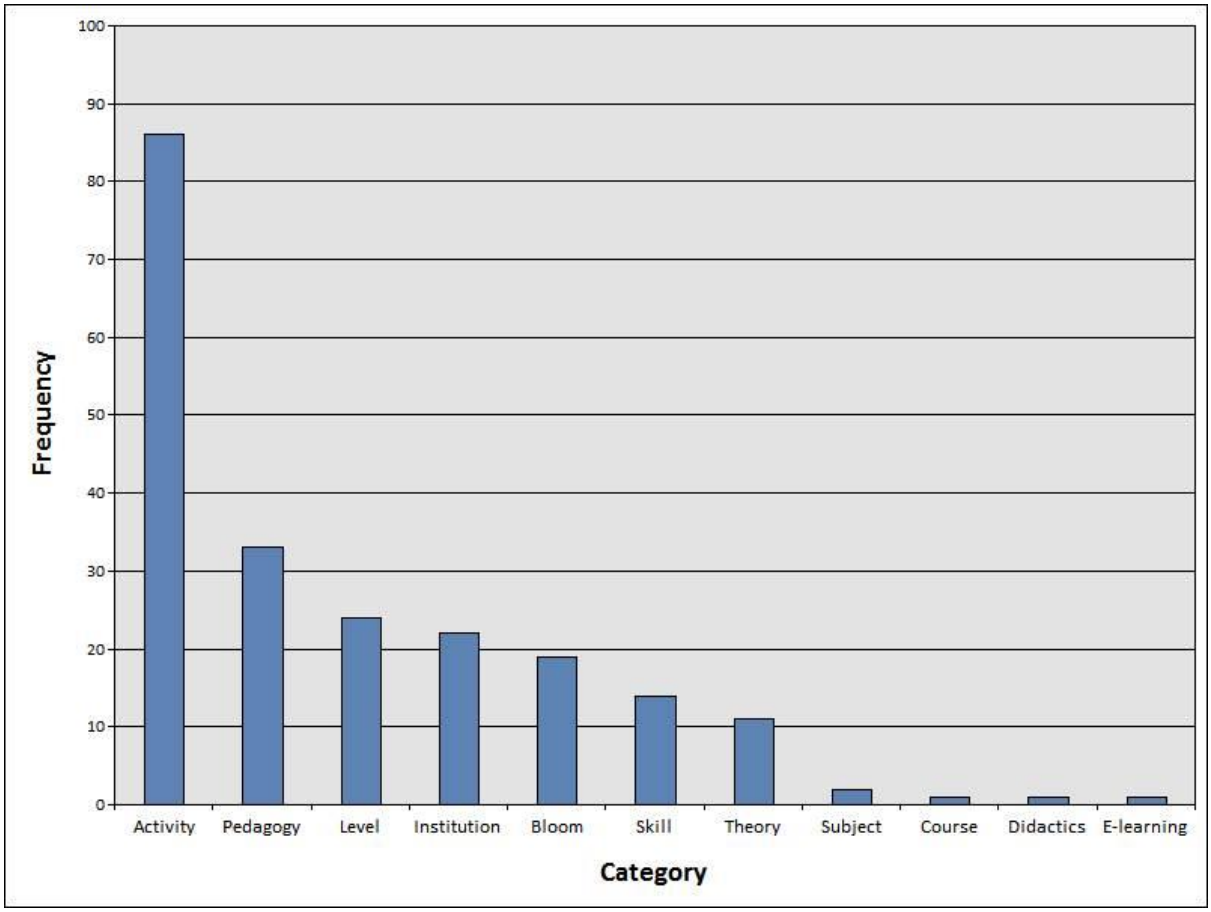


Figure 24: Demand side issues

There was a very energetic discussion about pedagogy, and Bloom's taxonomy, that also features quite high in the chart here. Inevitably, people wanted to talk about specific institutions, the differences between (or features of) primary, secondary and tertiary education, and there was occasional focus on skills (computer literacy) and educational theory.

A typical comment about activity (passing exams):

> *I am not sure this is necessarily obvious. How is learner success defined? Is this about **passing exams** which tests competencies that are irrelevant and inappropriate to the learners socio-cultural context? (Participant 13)*

It was surprising that the discussion never became substantially involved with the differences between different subjects for learning, and even e-learning seems to have dropped off the preferred agenda. The discussion of pedagogy was not always done with confidence:

> *… you are maybe referring to a version of "the 3 R's" sort of the entry level "knowledge" (goodness, [I'm] not very confident to throw around some words in **a discussion on pedagogy**!) that you would need to enter a Community of Practice. (Participant 33)*

Management issues

There was considerable discussion about management issues. The frequent references to learners, teachers, parents, policy makers and others generated a high count of references to stakeholders – at the heart of much of the discussion. Learners and teachers featured frequently:

> *I think the interesting question for me would be are do we understand what are the needs of both the **learners** and the **educators** in terms of usability (Participant 07)*

Government featured often, not always positively:

> *I don't know. I wish I knew. **Government** is such a mess as it is. It's their views about what educ ought to be for us to be globally competitive that's questionable. So sadly all other efforts will be haphazard and localised revolutions in the small. (Participant 09)*

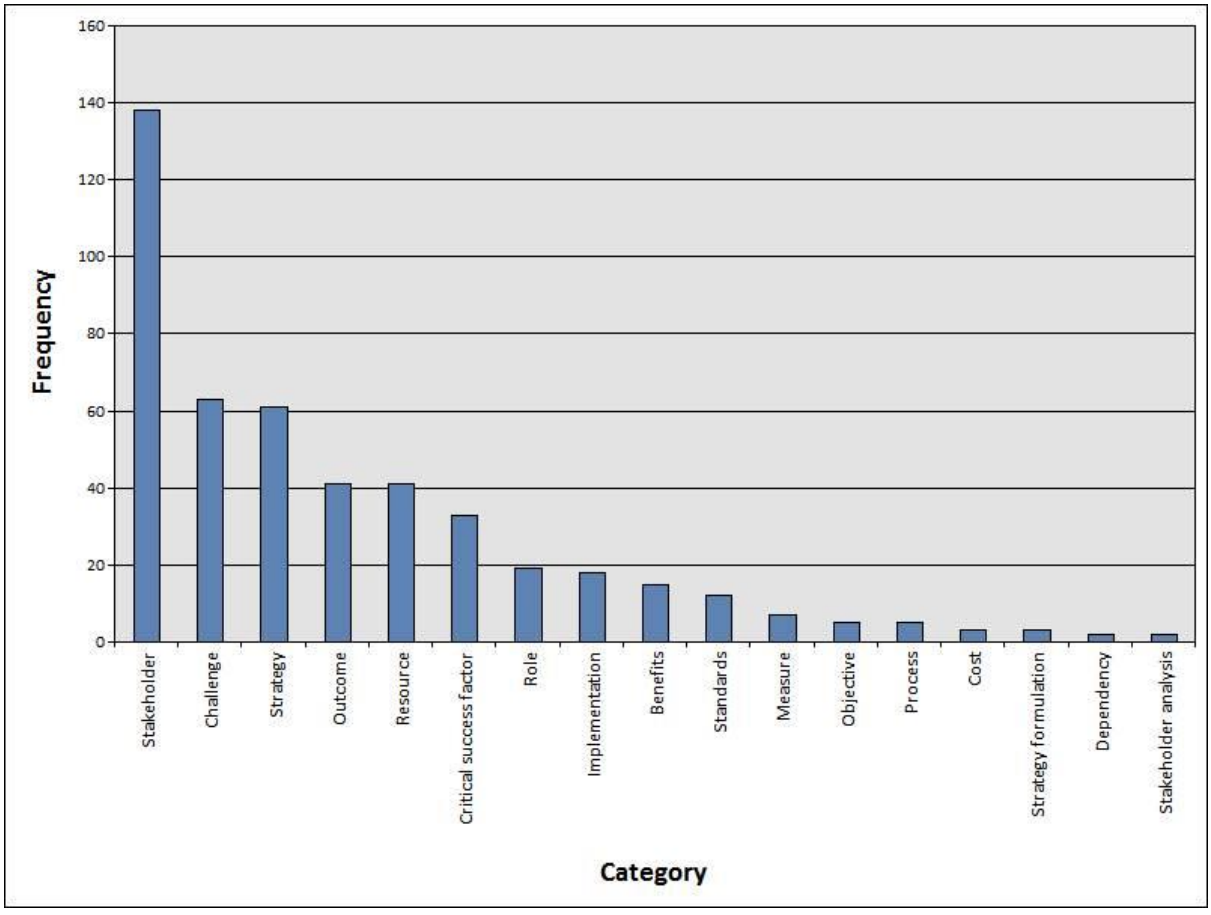


Figure 25: Management issues

Strategic issues came through quite strongly (including challenge, outcome, critical success factor, implementation, benefits and strategy formulation, just!). Generally, we should be pleased that there was such an interest in management issues, and that there was such a range of topics to discuss.

Context

These issues were not specific to management, education or technology, rather they were concerned with the context within which education happens. "Need" and "opportunity" are to be expected, regional issues are always close to our concerns, and other interesting things such as initiative, attitude, and even the relations with business are all evident.

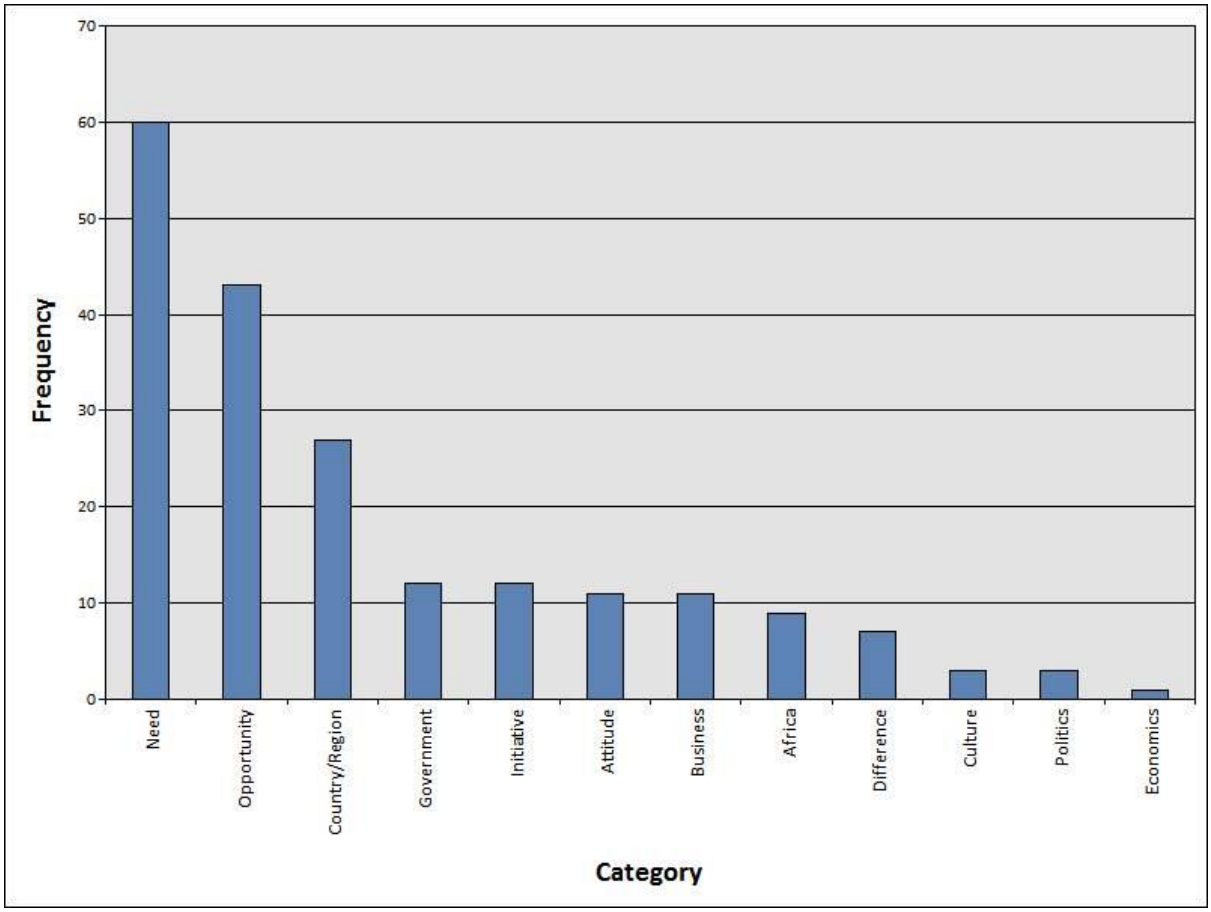


Figure 26: Issues of context

Some examples will illustrate some aspects of the discussion. First, about the matter of *differences* that features elsewhere, but not so much in the Flash MOOC:

> *Yes, but who or what is the "community"? In management "theory" we deal with the **different kinds of community** by means of stakeholder analysis. (Participant 28)*

Quite so! An example of a contextual question:

> *What is the role of **social media** in learning and teaching? (Participant 34)*

And an example of an assertion about the importance of understanding the context:

> *The point is not what we consider to be mature technology, but **the context in which the intended target market is at**, in terms of knowledge of available technology (Participant 12)*

Management

It is also possible from the narrative that comes from the Flash MOOC to develop a more structured discussion about the key issues.

Take *management*. Here is the beginning of a discourse on managing the present pressures to change the way education works, that could easily be developed into a ten-page discussion about approaching management, featuring the need for change, raising some of the expected problems, and deciding on a strategic approach according to the degree of experience already in hand:

1. It's hard work selling an idea to management:

   … it's an idealistic notion for management to adapt to changes and to engage. I think the idea needs to be 'sold' to management for them to 'buy' into it. My (narrow minded) opinion on management is that they're [only] interested in the bottom line. Can one make a difference in practice? (Participant 05)

2. But there may be ways to dealing with the problem:

   … in terms of dealing with management, it is CRITICAL to meet them on their own ground. That means understanding what motivates them and drives them, and understanding the goals that they have – individually and in their role in the organisation. The more we talk from an alien, specialist viewpoint (whether as dyed-in-the-wool educators, or as IT specialists) the less credibility we have ... management want to have a managerial conversation and that means speaking to organisational OBJECTIVEs and STRATEGY. Tragically, many organisations have no strategy, or it is a pie-in-the-sky strategy that everyone chooses to ignore. (Participant 28)

3. Some specific questions about the management of change:

   What would be considered in education [to be] successful integration? How much [is the] cost of ownership? How do we measure what we do? How will we know whether what we do will benefit all stakeholders? And that's all before we even start to imagine how different a school and classroom [will be] with high tech functions! (Participant 09)

4. And perhaps we are facing issues of ethics when implementing analytics:

   … "big data" in education - you once implied (long time ago!) that that would not be ethical .. what do you think now? (Participant 17)

5. The depth and rate of change, and the disadvantage arising:

   … you have vast online learning systems and electronic communication for learning, which has continuously been on the rise because of the benefits it offers the students and flexibility of the management as well. It's a thing of concern to see others struggling still in the medieval way of management and processes, which impacts the current level of their use in technology for education. (Participant 18)

6. Force-fitting technology without regard to educational needs:

   From [the] management perspective what I see [is] an attempt to add technology as an additional layer to existing education without realising the extent to which pedagogy must change. Also what happens on the ground. Simple example. Image a laptop [in a] school: is a 45 minute lesson practical, given things like start up time, technical difficulties, etc etc? (Participant 09)

7. Push and pull

   If we ask the question: is it about technology push or educational pull, then educational pull should be the choice (in my opinion). There is much work ahead of us. (Participant 30)

8. Responsibility for infrastructure

   No, I do not think that the infrastructure should be a primary management issue - but in today's networked world it is a prerequisite for delivering ICT-based education. Hence, without this

prerequisite, [management] is limited only to in-house ICT-related issues. This, then, excludes online education. In short, I suggested to add another element to the technology management considerations. (Participant 17)

9. Stakeholders are always going to be a focal issue:

   Students and parents are the most [important] stakeholders in education and the funny part [is] the power lies in the hands of management. (Participant 37)

10. Let's recognise that things mature, and the way that we manage will change:

    Yes, in the simple view there HAS to be a simple sequence – "think, plan, act, check" - but when we are dealing with NEW ideas we have to accept (in my view) that there will be some chaos. So, I will always argue that management has to be different for: those ideas that are new, those ideas that are in the process of adoption, those ideas that are established and seen as routine, and those ideas that have had their time … Do we not need to separate the management at these different stages? (Participant 28)

Results out of the Flash MOOC

As an experiment, it was not at all clear what was expected out of the Flash MOOC other than raw learning, about new forms of engagement between teachers and learners, the potential benefits of services on the social web, and (as is evident from the above) the merits of using digital tools to analyse qualitative research data. Treating the whole narrative as qualitative research data proved to be immensely useful in testing and stabilising the features of a home-grown analyser (described briefly in the next main section of this report).

Some key learning points from the Flash MOOC exercise:

- It is possible to mount such an exercise with absolutely minimum resources and quite limited effort.
- Build it, and people will come.
- When they come, they will demonstrate that it is easier to chat than to debate.
- There is value in allowing people to bring their knowledge, and their sources, to share.
- The structure of such an open discussion is important to keep things on track, but there will be copious evidence of the things that were not anticipated.
- Drawing things to a conclusion is not easy, but further experimentation will show the way.

Acknowledgement

Special acknowledgement is due to Laban Bagui, who took up the challenge to develop and run the Flash MOOC and takes virtually all the credit for its success.

Appendix 4: The Qualitative Content Analyser (QCA)

At the time that this project was starting, there was already an un-funded initiative to develop a free-to-download **qualitative content analyser**. The rationale for such a project was that several research projects (at doctoral and masters level) had invested quite heavily in commercial software products intended to facilitate this kind of research and analysis, but research students found that these products were complex, sometimes unreliable, difficult to fit to a research strategy, and of course they are expensive (although, increasingly, tertiary institutions are acquiring site licences).

The opening of a published paper (Bytheway, 2013b) provides some background:

> *Experience with young research students in South Africa, most of whom have few or no resources and are not supported by research infrastructure by their universities, shows that they have great difficulty in learning the techniques of qualitative research. Beginning as a simple idea, the development of an ad-hoc package intended to assist with the coding and categorisation of qualitative data led to a useful suite of facilities that contributed to at least four projects, one of which had the texts of 52 interviews to work with. It proved possible to import, structure and organise the research data in a way that then permitted useful export of charts, tables and text into papers and theses. With appropriate skills, researchers also found it possible to apply their own SQL queries to data that was now well structured and fully normalised (in terms of database design). Comparison with two commercial packages shows that many of the proclaimed features of the commercial packages were replicated, and in at least one instance they seem to have been exceeded.*

Overview of QCA

The package allows the importation of text, typically interview transcripts or selected text from printed works. This might be referred to as the "bulk" text, and in the case of the Flash MOOC (which will be used to illustrate use of the QCA here) the complete written record of the eight-hour discussion comprised the raw input.

Then the text is broken down into "chunks" that represent single components of the larger text, typically a question and an answer, but sometimes a much longer section of text that has been deconstructed into the parts that represent one component of the narrative.

Then, a set of categories needs to be established that can be used to "code" the chunks of text. This can be a set that is pre-determined (*a prior* research) or it can be allowed to develop during the analysis (*a posteriori* research). In the case of the Flash MOOC, the latter was the chosen approach.

Careful inspection of the chunks allows the categories to be coded against them, so as to create a map of what people were talking about, and how often. This then becomes the basis for charts and reports.

Examples of both are seen above. Each of the italicised quotations is taken directly from the QCA; the frequency charts are also immediately available and can be exported as JPG files for inclusion in a journal paper or a thesis.

Some images

The operation of the QCA is achieved via a Control Panel that offers seven tabs, corresponding to the stages of an analysis.

1. Set up the basic data
2. Undertake the text management and coding
3. Browse the results
4. Produce charts and reports

5. Undertake second-stage inferential analysis
6. Set up options for data labelling
7. Diagnose the condition of an in-progress data set

This is seen in the following figure, that shows through the browsing tab how the QCA allows navigation through the data according to its logical structure:

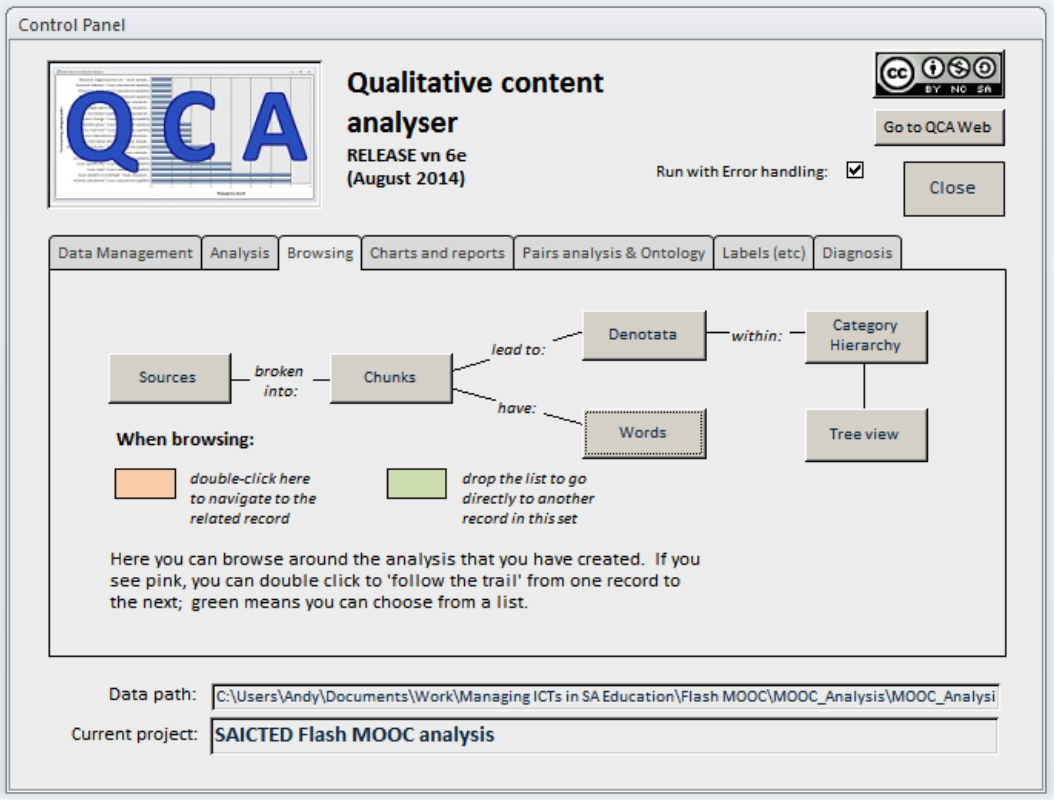


Figure 27: The QCA control panel – "Browsing"

This is where it all begins, and the reader is referred to the support web site

http://qualanal.wikispaces.com

for more information and for download options. Several support videos are available on YouTube, starting with an introduction to qualitative research:

http://www.youtube.com/watch?v=ii0YGjAia5M

At the time of writing, release 6.0 of the QCA is imminent.

Following are some images of the working screens.

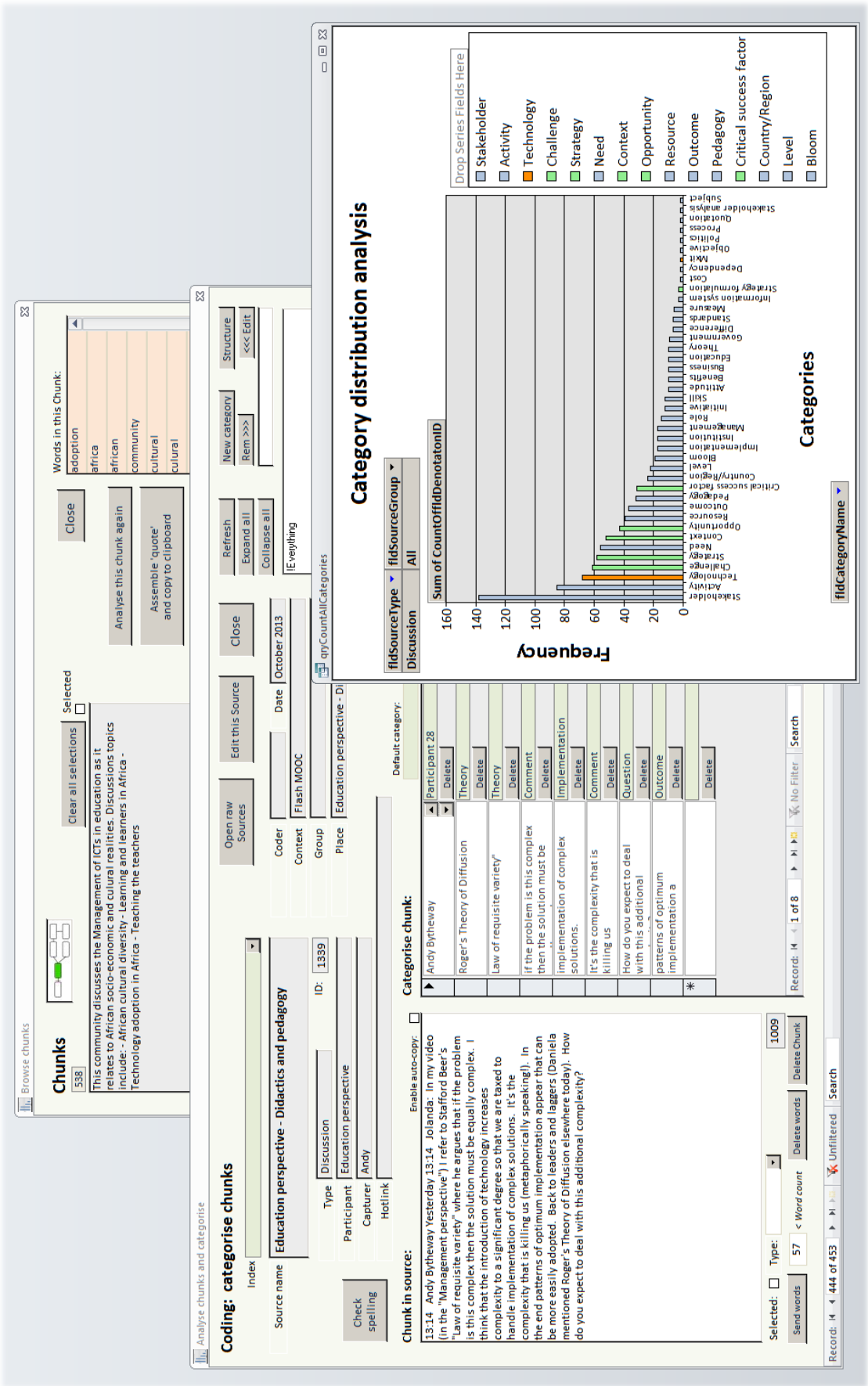


Figure 28: Sample screens from the QCA package

Appendix 5: Bibliography

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Appendix 6: Chronology

Nominally, the project extended over three years, but for reasons that are explained elsewhere the whole of this time was not actually available for productive work.

Some significant events and milestones are given below.

Date	Item
Stage 1:	**Initiation**
5 November 2010	Confirmation of the award received from the NRF
27 January 2011	Student recruitment commenced
25 March 2011	Letters to successful applicants sent out
12 May 2011	NRF approval received for bursaries
4 June 2011	Core team meets for first discussions, Riebeek West
Stage 2:	**Work begins**
17-19 October 2011	First full team meeting held in Polokwane
26 October 2011	Andy presented at "ICT in Higher Education" in Johannesburg
29 October 2011	Andy presented at CPUT Education Research colloquium
27 January 2012	Andy 2012 plan circulated
Stage 3:	**Work falters because of resourcing issues**
21-23 March 2012	Second team meeting at Goedgedacht
22 June 2012	Andy presented at IFSAM 2012 conference in Limerick, Ireland
12 July 2012	Review meeting with the NRF at CPUT, to discuss problems
Stage 4:	**Getting up to speed again? With only some success**
Aug-Nov 2012	Bursars asked to focus on personal research
4 December 2012	Management meeting at Goedgedacht
15-16 January 2013	Meeting of Experts, Hotel School, Granger Bay
1 March 2013	Registration deadline for bursary students passes – but none are able to register
19 June 2013	First bibliography (522 papers selected out of more than 700)
28 June 2013	Andy presented at international ICEL conference at CPUT
29 June 2013	Work begins on the Reference Model
12 October 2013	Flash MOOC happened on this day – work starts on finalising the bibliography
17 December 2013	Bibliography finalised – reading begins (159 selected out of the 522)
Stage 5:	**Wrapping up**
7 January 2014	Completion plan agreed and adopted
Jan-Nov 2014	Intermittent attention to the finalisation of the project
31 November 2014	Final report submitted