

Chapter 5

Conclusions and recommendations

5.1 Overview of chapter

This Chapter opens with a brief summary of the research presented in this study. This is followed by an integration of the findings presented in Chapter 4 with views presented in the literature and the conceptual framework, presented in Chapter 2. The dialogue arising from this integration is followed by a brief summary and pointed evaluation of such dialogue. Subsequently, anomalies and differences between the findings and the literature are elucidated. These differences inform the adapted design of the conceptual framework presented in Section 5.3.3.

Having addressed the similarities and differences between the findings and the literature, the discussion moves to a reflection on methodological, substantive, scientific and exploratory aspects of this study. Finally, recommendations for policy, practice and further research precede the conclusion to the study.

5.2 Summary of this research

The motivation for this research was derived from my own experiences as a secondary school teacher, and Head of Department tasked with the development of information technology in the institution. I became aware of the fact that some teachers seemed to integrate computers effortlessly into the taught curriculum, whilst others found it impossibly difficult – all within the same institution. This led to questions surrounding not only the initial uptake of such integration amongst teachers, but also questions surrounding the sustainability of such integration. On being made aware of the CALIS Project that had taken place in the Free State Province in the early 1990's I realised that the Project presented an excellent opportunity of exploring possibilities with regard to my concerns.

From this exploration, the following research question was derived:

How did influences on the implementation of the CALIS Project affect the sustainability thereof?

This research question was later expanded and formulated as five, related sub-questions:

- 1. How did personal qualities, possessed by people directly or tangentially involved in implementing the Project, influence the implementation and sustainability of the Project?*
- 2. How did elements of programmatic design (those elements of programmatic design specifically embodied in the goals of the Project) influence the implementation and sustainability of the Project?*
- 3. How did the availability of physical resources during implementation influence the sustainability of the Project?*
- 4. How did the larger systemic environment in which the Project was implemented, influence the sustainability thereof?*
- 5. How was the further development of the Project affected by the animated, interactional interrelatedness of the complex system infused by all of the influences mentioned above?*

What follows is a dialogue between the literature and conceptual framework, presented in Chapter 2, on the one hand, and, the findings of this research study, presented in Chapter 4, on the other. The issues addressed are those raised in each of these sub-questions.

5.2.1 Research Question 1

- 1. How did personal qualities, possessed by people directly or tangentially involved in implementing the Project, influence the implementation and sustainability of the Project?*

On the national structural level (4.3.1.2), personal qualities possessed by the lecturers and students involved in the M.Ed. C.I.E. at the University of Pretoria are perceived by participants to have had a very positive influence on the Project. Mooij and Smeets (2001) refer to the importance of active participants at all structural levels of the educational system, and Ely (1999a) refers to the importance of knowledge and skills amongst teachers. Yet, there is no specification in the literature of specific skills at various structural levels of the education system that are likely to influence the successful integration of computers into classroom practice.

With reference to this differentiation, participants in the study noted that the qualities possessed by the then Director-General of Education in the Free State (Mr Heyns), namely his enthusiasm for computers in education, visionary leadership and financial management expertise, similarly had a positive influence on the sustainability of the Project on regional level (4.3.1.3). Some of these qualities were also identified in Dr Venter, the Project co-ordinator and manager, but, in addition, he is deemed to have been: innovative; a strategic

planner; an inspiring manager who was not afraid to adopt an unorthodox managerial style; an energizer; and someone who fostered communities of practice. Such qualities seem to have been well-suited to his role as strategist, planner and energizer of the Project. Similarly, Hercules Dreyer's capacity for hard work and his determination accord very well with his role as implementer of the Project - so also, Johan Badenhorst's pure intentions, passion for the Project, empathy, and willingness to help accord very well with his role in the Project - namely that of teacher support. Ely (1999a) refers to the importance of leadership in determining the successful implementation and sustainability of such educational projects, but this suggestion applies to leadership at institutional level and does not envisage the finely-nuanced, layered matching of personal qualities with specific roles identified by the participants in this study.

The fact that institutions were approached to take part in the Project (4.3.1.6) but were not coerced into doing so, meant that principals who became involved did so because, like Maureen Dale, they foresaw ways in which their institutions could be enriched. What is also clear is that such principals, and members of school management teams, envisaged the Project contributing positively to the system as a whole, and not merely to their individual institutions. In support of these findings in participant narratives, the literature is replete with references to the importance of the existence of knowledge and skills at school leadership level (Ely, 1999a); the importance of staff development (Becker, 1999a, 2000a, 2000b; Shuldman, 2004; Mooij and Smeets, 2001); and the importance of principal and school management leadership (Baylor and Ritchie, 2002; Shuldman, 2004).

In contrast, some of the major concerns expressed in the literature, such as the scheduling of computer time (Pelgrum, 2001) and the importance of a full-time technology coordinator (Becker 1994, 2000a, 2000b) are not supported by participants, essentially because the classroom-based implementation of computers precluded the possibility of computer laboratory congestion (at least, initially) and the perception of limited resources on the part of educators in most schools precluded any thought of school-based technical support.

But some form of support across institutions is reported to have come from a source not anticipated in the literature, in the case of two of the participants interviewed. In the case of Ronel Calitz, her husband was the principal at a nearby school, and, in the case of Sarie du Plessis, her husband taught at the secondary school attached to the primary school at which she taught. Furthermore, both were technology coordinators for their respective schools. The influence of close personal relationships across contiguous institutions is not contemplated in the literature as a contributory influence to the successful integration and sustainability of computers in classroom practice.

Just as schools were not coerced into taking part in the Project, so also educators could choose whether they wanted to be involved or not. Voluntary participation of educators in the Project (4.3.1.7) meant that those who did choose to become involved were, by definition, educators who were, at best, passionate, or, at worst, interested in the integration of computers into classroom practice. But, besides such interest, participant narratives identify very specific qualities associated with educators who became involved: they were naturally curious and embraced innovation and change; they were generally subject matter experts who sought solutions to educational challenges; they generally viewed teaching as a calling, and were committed to the improvement of their craft; and, perhaps most importantly, they were possessed of above-average drive and determination.

No mention is made in the literature of teacher drive or determination as an important influence on the implementation and sustainability of computer-integrated education. Veen (1994, 1995) argues that teacher factors outweigh all other factors influencing the successful implementation and use of computers in classroom practice. In this regard, Ten Brummelhuis (1995) and Ten Brummelhuis and Tuijnman (1992) argue that teachers' perceptions regarding the relevance of the innovation is by far the most important factor. This view is supported by Baylor and Ritchie (2002), who feel that teachers' openness to change is the crucial factor. If this is the case, then the decision to involve only teachers who were convinced of the efficacy of computer-integrated classroom practice would have contributed significantly to the success of the CALIS Project.

Ely (1999a) postulates dissatisfaction with the existing state of affairs, the existence of teacher knowledge and skills, and the availability of time as key conditions for the implementation of computer-integrated education. The first two pre-conditions are met in participant narratives, but very little mention is made of lack of time – possibly because teachers who took part in the Project were internally motivated and did not experience the extra work that they took on as a burden. One of the most widely-reported obstacles to the integration of computers in classroom practice is the lack of teacher skill regarding integratory practices, and the concomitant negative impact on teacher confidence (Pelgrum, 2001; Mooij and Smeets, 2001; McMullan, 2002). Participant narratives are generally devoid of references to this perceived problem. The answer might well lie in the fact that volunteer-teachers decided to take part in the Project exactly because they were looking for a way in which technology could help them to solve educational problems. In contrast, as mentioned above, the hardware infrastructure in many developed countries preceded related pedagogical practices and thus provided a technological imperative for computer-integrated education,

rather than an educational one. McMullan (2002) argues that one of the major problems associated with the integration of computers into classroom practice is the fact that teachers have not been able to adapt their practice to embrace new technologies. The question that arises is the following: is such adaptation sought for the sake of enriching learning and teaching or is such adaptation sought for the sake of accommodating innovative technology?

5.2.2 Research Question 2:

2. How did elements of programmatic design (those elements of programmatic design specifically embodied in the goals of the Project) influence the implementation and sustainability of the Project?

The planning of the CALIS Project included an initial research and information-gathering phase (4.3.2.1) which involved, amongst other things, a tour to institutions in the United Kingdom and the United States of America and attendance of the National Computing Conference in the U.S.A. Although Mooij and Smeets (2001) envisage the influence of active contributors to the success of a computer-integrated education project at all structural levels of the educational system (also the international level), the nature of such active contributions is never explored any further. Also, no indication is given of what exactly constitutes 'active' involvement. Presumably the host institutions, possessed of the necessary knowledge and skills (Ely, 1999a) sought by the Project initiators, were quite willing to receive their guests from South Africa, but it can hardly be argued that their role in the CALIS Project was anything other than passive, and yet, the knowledge and skills gained by the visitors were invaluable in planning and implementing the Project on their return to South Africa.

The same cannot be said of the partnership entered into by the CALIS Project team and the University of Pretoria's Computer Integrated Education (C.I.E.) contingency on national level (4.3.2.2). After having conducted research into the relative level of expertise resident at South African higher education institutions in terms of computer-integrated education, the Project managers approached the C.I.E. group with a view to entering into a partnership. The role played by the C.I.E. representatives in the ensuing partnership was not only active but positively inspiring, as mentioned above. Proof of such inspiration is the fact that many teachers involved in the Project enrolled in the M.Ed. (C.I.E.) at the University of Pretoria after having been exposed to the contribution to the Project made by this programme. The participation and commitment of teachers envisaged by Ely (1999a) as an important influence on the success of similar projects is thus also true of active participants at other structural levels of the education system. The same can be said of the importance of school leadership, identified by Ely (1999a).

On regional level (4.3.2.3), the interrelatedness of programmatic and systemic influences is clearly visible. The implementation of a regional computer literacy programme amongst teachers does not fall within the gambit of programmatic influences, as defined in the sub-question, since it is not part of the CALIS Project as such. Yet, the vision for the integration of computers into schools was systemically approached as a three-phase process: a computer literacy drive; the introduction of computers in schools as administrative tools; and the integration of computers into the taught curriculum. Such interrelated horizontal influences that cut across vertical structural levels are not explicitly addressed in the literature. The computer literacy drive that preceded the CALIS Project led to the establishment of five computer centres, one in each of the districts of the region. These centres were later used for teaching of Computer Science as subject since there was a dearth of expertise at schools. When CALIS was implemented, these centres served as district-based support centres for the Project. Besides references to a 'phased approach' (Mooij and Smeets, 2001; Armstrong et al., 2004), the literature tends to approach the integration of computers into the classroom as a stable process that is not dynamically co-determined by system-wide influences. For this reason, the concept of ecological or viral change in educational systems and the concept of sustainability in complex educational systems, introduced in the conceptual framework, address such dynamism in two ways. Firstly, Cavallo (2004, p.97) argues that participants in such systems "design and introduce new variants along certain principles and see how well they grow". This process, he argues amounts to appropriation and experimentation. So, the process is anything but stable and predictable. Secondly, Fullan (2005) emphasises the systemic interrelatedness of influences by postulating contextual change at all levels as an essential element of sustainability in complex educational systems. The integration of computers into classroom practice as complex educational process is thus neither stable nor predictable. As such, we should expect complex interrelated influencing of the system, both vertically and horizontally.

The same point is made by participants with reference to the project structural level (4.3.2.4). The CALIS Project was never intended to be a stand-alone project, but was meant to be one of a triad. CALIS and the other projects, namely FRENET (Internet connectivity) and FRETTEL (television-based instruction and administration), were intended to be seen as addressing educational needs in the region in an integrated manner. Pelgrum and Plomp (1993) claim that one of the most worrying obstacles to the integration of computers into classroom practice in the 1990's was the fact that school principals were not able to formulate clear goals relating to such integration. In the case of the CALIS / FRENET/FRETTEL triad, these goals were formulated at project level and principals did not have to do so. So also,

envisaged obstacles to successful implementation for sustainability such as the lack of time on the part of teachers (Ely, 1999a) and the difficulty of integrating computers into classroom practice (Pelgrum 2001) were not felt at the level of the institution since much of the work had been done at the level of the project. Once again, the literature wishes to address these obstacles discretely at the level of the institution, and does not contemplate the “intelligent accountability and vertical relationships” identified by Fullan (2005, p.14) in the conceptual framework as one of the essential elements of sustainability in complex educational systems. A cogent example of such intelligent accountability is Dr Venter’s establishment of the CALIS infrastructure based, partly, on the realisation that such an infrastructure held the promise of enabling sustainability of computer-integrated education under the new political dispensation.

The CALIS /FRENET / FRETTEL triad had another very important goal, namely the establishment of horizontal networks of teachers who shared resources and expertise, rather than reinforce the existing culture of competition and isolation. The literature does not contemplate the convergence of institutional and regional culture with the objectives of complex educational projects in co-influencing successful implementation and sustainability. In this regard, the conceptual framework offers theoretical grounding in the form of Fullan’s (2005) insistence on the importance of lateral capacity building through networks. Such networks are energised by systemic thinkers and actors at all levels of the system and result in contextual change (thus also institutional and regional change in culture) in the system as a whole.

As far as the educational objectives of the Project are concerned, participant narratives are unanimous in the view that the primary objective of the Project was the full integration of computers into teaching practice at regional level. A secondary objective was full regional diffusion of computer literacy amongst all teachers in the region. The philosophy underlying implementation was that the Project would initially serve white schools only but that infrastructure would be put in place with a view to serving all schools in the region under the new dispensation.

Furthermore, the Project was to contribute to bringing about changes in educational practices. In this regard, Hawkins (2002) endorses the importance of linking computer-integrated education to broader educational reforms in developing countries. Whereas existing practices at the time favoured the development of cognitive skills, the Project would set out to enable the acquisition of a wide range of cognitive, connative and sensori-motor skills. This would go hand-in-hand with a move away from the solely instructivist pedagogical practices to a

more varied approach, including cooperative, social constructivist practices. This view is endorsed by Kozma (2003) who argues that the adoption of computer-based education goes hand-in-hand with widespread adoption of constructivist learning and teaching practices. Pelgrum (2001) and Pelgrum and Plomp (2005) specifically refer to the centrality of active student involvement to the success of computer-integrated education.

Practically, this view found expression in the installation of 8-10 computers in a class of 30 pupils. Such a configuration would enable the use of computers by a third of the class at any given time – the idea being that the rest of the class could be divided into two groups, such that one would work independently and the other would be engaged in work with the teacher. The idea was, further, that expert teachers would develop course modules which could be accessed via the FRENET or FRETTEL systems. Furthermore, the presentation of annual expos and concurrent competitions for outstanding computer-integrated course modules would provide the ‘cyclical energising’ envisaged by Fullan (2004, p.14) as one of the essential elements of sustainability in complex educational systems.

One of the challenges facing the successful integration of computers into classroom practice identified by Shuldman, namely the ability of teachers to adopt innovation and cope with change, is only alluded in passing in the narratives. Far from being a challenge, the ability is mentioned as a characteristic of the teachers who chose to become involved in the Project. Yet another perceived challenge, namely the fact that many teachers use computers to teach the standard curriculum (Law et al., 2000; Scofield and Davidson, 2002), did not find expression in the narratives because teachers who chose to become involved in the Project, did so in the belief that computers could provide novel ways of approaching educational problems resident in the accepted, standard curriculum as it then existed.

Implementation of the Project at the institutional structural level (4.3.2.6) took place with due consideration being given to local contexts and the kind of support that was elicited from school governing bodies, and wider parent and community bodies. The role played by these contextually-defined bodies related particularly to issues surrounding financial sustainability. Such financial sustainability enabled the appointment of a full-time technology coordinator (Becker, 1994, 2000a, 2000b) in some schools; staff development programmes (Becker, 2000a, 2000b; Shuldman, 2004; Mooij and Smeets, 2001) in some schools; and the development of principal and school management leadership in the field of computer-integrated education (Baylor and Ritchie 2002; Shuldman, 2004) in some schools.

Educators (4.3.2.7) who implemented the project in their classrooms did so, similarly, with due consideration of the district and institutional context within which such implementation took place. But, additionally, such educators viewed computer-integration as a way of addressing educational problems. In this way, both Ronel Calitz and Sarie du Plessis were primarily concerned about the teaching and assessment of reading at the Foundation Phase. The Project offered them a way of addressing the issue via the use of custom-made software. The literature (Ely, 1999a; Baylor and Ritchie, 2002; Shuldman, 2004) envisages leadership at institutional level as an important influence on the implementation and sustainability of computer-integrated educational projects. But there is a real sense in which teachers such as Ronel Calitz and Sarie du Plessis embody the new kind of leadership envisaged by Fullan (2005), where such leadership is defined as systems thinking in action, and is to be found at all levels of the system.

Such system-wide leadership, argues Fullan (2005), brings about contextual change at all levels. This certainly seems to have been the case on the structural level of the learners involved in the Project (4.3.2.8). The narratives bear witness to a change in learner perceptions and of attitudes towards pedagogical practices. The Project seems to have inspired curiosity, excitement and, eventually, the perceived need for computer-integrated education. There were even instances where learners became involved in innovative projects to ensure the financial sustainability of the CALIS Project at their institutions. Such evidence provides further support for Ely's (1999a) insistence on the importance of active student participation.

5.2.3 Research question 3:

3. How did the availability of physical resources during implementation influence the sustainability of the Project?

How did the availability of physical resources during implementation influence the sustainability of the Project?

Just as the interrelatedness of personal, programmatic and systemic influences on the Project cannot be overlooked, so also, physical influences cannot be seen in isolation. In this regard, physical influences on the international structural level (4.3.3.1) are not easily distinguished from systemic influences on the same level. On the one hand, narratives indicate ways in which standard *Windows* applications such as *MS Word* and *MS Excel* were integrated innovatively into classroom practice. In this way, specific physical resources were utilised, in a programmatic manner, in the implementation of the Project. On the other hand, the

implementation of the Project, fortuitously, coincided with the advent of *Windows* 3.1 and the first intuitive, widely available graphical user interface. Had such systemic coinciding not taken place, it is not clear what the influence on the Project would have been. It does not end here. Igno van Niekerk relates his own euphoria at installing his multimedia personal computer. The advent of multimedia computing made richer, more engaging learning environments a reality. With the arrival of the Internet and e-mail, such potential enrichment of the learning environment was accompanied by the possibility of communicating horizontally and vertically across the system in order to share resources and expedite administrative functionality.

The literature envisages two obstacles to the integration of computers in the classroom on the international level, namely the fact that the provision of computer hardware tends to outpace the diffusion of effective teaching practices (Moursund and Bieleveldt, 1999), and the fact that the 1990's were characterised by a dearth of educationally specific software packages (Pelgrum, 2001). The narratives suggest that the Project was, from the outset, an educational enterprise and, as such, was clearly informed by sound pedagogic practices. The implementation of the physical infrastructure was thus predicated on pedagogical principles, and not vice versa, as the literature suggests. Secondly, the Project-initiated use of *Windows*-based applications and shareware offerings obtained from the Internet meant that the dearth of education-specific software packages at international level was counteracted, to some extent. Also, the kind of appropriation and experimentation envisaged by Cavallo (2004) as a characteristic of evolutionary, ecological education systems was encouraged by the absence of numerous targeted educational software packages.

On national level (4.3.3.2), the availability of software that aided administrative tasks associated with teaching played a significant role in positively influencing the integration of computers into classroom practice. In this way, the availability of packages such as *As Easy As* and *Framework* bear witness to Ely's (1999a) insistence on the availability of resources as an important determinant of success. In terms of computer-integrated education in developing countries, Hawkins (2002) identifies an important influence on national level, namely the existence of telecom monopolies that impede connectivity and financial sustainability. Because South Africa was a divided society at the time, and because the Project was implemented in many relatively affluent white schools, the effect of this influence was not as severe as it might have been had implementation in all schools taken place at the same time?

Participant narratives indicate that one of the most important physical influences on the Project at regional (4.3.3.3) and project (4.3.3.4) levels was the way in which Mr Heyns

(Director-General, Education) enabled the availability of funds for the Project, thereby lending support to Ely's (1999a) insistence on the existence of knowledge and skills, and the availability of resources, as important influences on the implementation of computer-integrated education. But, once again, the literature deals with such influences in a discreet, static fashion. Dr Heyn's contribution to the sustainability of the Project must be seen against the backdrop of his own vision for computer-integrated education, which preceded the CALIS Project and which held implications for the anticipated new educational system brought about by political change in the country. Such service is better grounded in Fullan's (2005) conception of "public service with a moral purpose" as one of the essential elements of sustainability in complex educational systems. Such was the impact of financial management and infrastructure creation, that by the time government support for the Project was withdrawn, the physical infrastructure was virtually in place. This fact was, partly, made possible by the financial support of local businesses. On the one hand, many local businesses sponsored the generous prizes offered to winners of the competitions run in tandem with the annual expos. On the other hand, Absa Bank offered the OFSED satellite bandwidth at a greatly reduced rate so that the FRETTEL Project could be realized. This involvement on the part of local and national business organizations embodies the kind of private-public partnerships envisaged by Armstrong et al. (2004) and McMullan (2002) as crucial elements of sustainability with reference to future projects involving computer-integrated education. Additionally, with specific reference to the district level (4.3.3.5), narratives document the fact that schools situated in larger urban areas could command much higher school fees and thus financial sustainability of the Project was far more likely to be the case in such institutions.

On the institutional (4.3.3.6) and educator (4.3.3.7) levels, managers of the Project entered into agreements with schools whereby the purchase of computers would be jointly funded by the OFSED and individual institutions. This meant that even relatively poorer rural schools could implement the Project in a more sustainable manner. Also, the importance of the student-computer ratio emphasised by McMullan (2002) was taken cognisance of. In this way scarce resources were pooled most effectively (Ely, 1999a; Cawthera, 2002) and the community was encouraged to take ownership of the Project. Such community involvement is seen by Hawkins (2002) as one of the ten principles that underlie the sustainability of computer-integrated practices in developing countries.

5.2.4 Research question 4:

4. How did the larger systemic environment in which the Project was implemented, influence the sustainability thereof?

How did the larger systemic environment in which the Project was implemented, influence the sustainability thereof?

The interrelatedness of categories of influences on the implementation and sustainability of computer-integrated educational projects has already been mentioned. Admittedly, the categories identified in participant narratives are, to some extent, abstractions of a far more complex reality. Yet, the literature on the sustainability of such projects offers numerous suggestions in terms of important influences. As pointed out above, however, such suggestions are presented as individual influences, and the interrelatedness of such influences is never pursued in more than a cursory fashion. The prevailing approach in the literature is at an even greater loss to account for influences related to synchronous systemic functionality. Consequently, it is the conceptual framework postulated for this study that provides much of the theoretical grounding for these influences, rather than the existing literature on the topic. As a result, the study suggests a conceptual framework within which such theoretical grounding may be achieved. Essentially, concepts from complexity theory, systems theory, autopoietic theory, theory relating to the sustainability of complex educational systems, and relevance theory are combined to present a theoretical foundation that is able to account for the sustainability of a dynamic, complex computer-integrated education project, namely the CALIS Project.

As elucidated above, the availability of physical resources during the implementation of the Project fortuitously coincided with the advent of *Windows* 3.1 and a concomitant freely-available graphical user interface. Such ‘fortuitous coincidence’ is not accounted for in the literature on sustainability, but it is a defining characteristic of dynamic complex educational systems as envisaged by Senge (1990, 2000), Stacey (1992, 1996) and Fullan (1993, 2001, 2005). Furthermore, complex systems are characterised by unpredictability brought about by non-linear mutual feedback loops and unanticipated lines of development. One of the reasons for this unpredictability, according to Cavallo (2004) is the fact that host environments in which such projects are implemented is unique. Multiple, interrelated influences on the sustainability of the Project thus stem from the system as a whole, explaining not only

‘fortuitous coincidence, but also the context-sensitive way in which the Project was implemented in individual institutions and individual classrooms.

Similarly, on the national (4.3.4.2) structural level, participant narratives report systemic influences on the Project that influenced the implementation and sustainability of the Project positively. One of the systemic influences that might well have contributed to positive attitudes towards the Internet and e-mail is the vast distances that separate communities on the South African landscape. Another is the fact that the implementation of the CALIS Project ‘fortuitously coincided’ with focuses on the problem-based approach in Mathematics and the communicative approach in English. But some systemic influences are even more subtle than this. Igno van Niekerk recounts how, prior to the implementation of the CALIS Project, male teachers who could type were stereotypically labelled as ‘gay’. And yet the ability to type was a valuable skill relating to routine administrative functionality surrounding the typing of class notes, tests and examination papers. The Project offered male teachers the opportunity of honing their typing skills in a socially acceptable fashion. Today the stereotype no longer exists. Fullan (2005) addresses exactly this kind of influence when he claims that national, regional and institutional culture is an important influence on sustainability. Such culture is part and parcel of context. It is the goal of systems thinkers at all levels of the system to change the context in which the system functions. In this sense, the male teachers who took part in the Project were systems thinkers and actors.

Cavallo (2004) suggests that participants in dynamically complex ecological educational environments design and introduce new variants into the system in order to see how well they grow. Support for this view is provided in participant narratives with relation to systemic influences on the institutional structural level. Managers of the CALIS Project insisted that computers had to be installed in classrooms. With the passage of time, however, many institutions removed these computers from classrooms and installed them in computer laboratories. The decision was motivated by considerations of cost-effectiveness and partnerships with private companies providing computer training. So, host specific environmental or contextual factors motivated individual institutions to ‘introduce a new variant into the system’. Another institutional-level systemic influence on the sustainability of the Project was the fact that remedial teaching typically took place in a remedial classroom on a one-to-one basis - the ideal environment in which to implement computer-integrated learning, particularly in the light of the ‘fortuitous concurrent’ development of the Rose Reading programme by Ronel Calitz. Once again, the system in which the Project was implemented followed the behaviour of dynamic complex educational systems, as envisaged by Cavallo (2004) and Fullan (2005).

A further systemic influence on the Project, reported on the learner (4.3.4.7) structural level, is the fact that the teaching of Computer Science at the district computer centres, before the implementation of the CALIS Project, was so successful, that the subject became popular amongst learners. It was thus not the case that computers were completely foreign to learners when the CALIS Project was introduced – even in the context of computer-integrated course work.

5.2.5 Research question 5:

5. How was the further development of the Project affected by the animated, interactional interrelatedness of the complex system infused by all of the influences mentioned above?

How was the further development of the Project affected by the animated, interactional interrelatedness of the complex system infused by all of the influences mentioned above?

Categorically defined influences on the implementation and sustainability of the CALIS Project are presented above. Furthermore, numerous instances are highlighted where two or more influences, from different categories, are so entwined that it is difficult to separate out the effect of each on sustainability. In addition, mention has been made of the fact that the existing literature on the sustainability of computer-integrated education projects does not attempt to account for such ‘entwining’ in a cogent, theoretically-driven manner. As mentioned above, the study suggests a conceptual framework within which such theoretical grounding may be achieved. Essentially, concepts from complexity theory, systems theory, autopoietic theory, theory relating to the sustainability of complex educational systems, and relevance theory are combined to present a theoretical foundation that is able to account for the sustainability of a dynamic, complex computer-integrated education project, namely the CALIS Project.

The fifth research question, framed above, was by far the most challenging question. Answers to the preceding four research questions were, to a large extent, provided by the content of participant responses, and could have been elicited in other ways, such as the use of questionnaires. The dynamism of interrelated influences in a living, complex system was more difficult to capture. For this reason, I decided to elicit narratives from the participants. I was convinced that elements of narrative structure and narrative style would provide me with data that would address this research question. Such data, on analysis of the narratives, did

not reside in narrative structuration, as I had thought it would, but in the metaphoric patterning that emerged across narratives. Such patterning is not contrary to that which is to be expected in dynamic, rhizomatic structures associated with complex, living systems. But analysis of such metaphoric patterning had to proceed according to a theoretical approach consonant with the theories relating dynamic complex systems.

The traditional view of metaphor (Lakoff and Johnson, 1980) as figurative construct postulates the mapping of a literal meaning to a figurative meaning within the gambit of a culturally –defined process. Such a view is mechanistic and simplistic. In contrast, Relevance Theory (Sperber and Wilson, 1986, 1995; Pilkington, 2000) views metaphor interpretation as an inferential process which gives rise to the recovery of multiple implicatures. In the case of highly standardised metaphors, interpreters will recover a fairly narrow range of strong implicatures, whereas, in the case of very creative metaphors, interpreters will recover a wide array of weak implicatures, some of which will have originated with the interpreter, rather than the producer of the metaphorical expression. Such an approach accords well with theory relating to dynamic complex systems since it recognises plurality, complexity and is predicated on an acceptance of the indeterministic nature of metaphorical interpretation. In short, Relevance Theory presents a view of metaphor as the ‘language’ of complexity.

Patterning relating to personhood (4.3.5.1) elicited implicatures relating to the CALIS Project itself as living entity and human being. Senge (1990, p.13) argues that there is a crucial shift of mind that lies at the heart of the learning organisation: from seeing ourselves as separate from the world to seeing ourselves as connected to the world. In this sense, such patterning ‘embodies’ Senge’s (1990, p.7) claim that human endeavours are also systems and that participants in such systems are ‘part of the lacework’ themselves. Complex implicatures may be recovered. These relate to the participants in the Project as human, but, at the same time, part of a larger humanity, constituted by the Project as a whole. Just as human beings are subject to violence and suffering, so also the Project is subjected to violence and suffering. Just as human endeavour ends in death, the Project is perceived to have died. An aspect relevant to later metaphoric patterning is the use of metaphor associated with Christian endeavour. Participants are drawn from a society that openly proclaims Christianity. It is thus not strange to encounter in the narratives metaphors relating to teaching as a calling, conducted in missionary surroundings where the ‘unconverted’ (those opposed to the Project) have to be Christened.

But participants in the project also take on the role assigned to Adam and Eve in the Christian Bible, namely custodians of the ecological system that is the Project. Metaphorical patterning

relating to ecology (4.3.5.2) stresses connectedness, situatedness, nested ecological systems and the rhizomatic, plant-like growth and spread of the Project. As such, this patterning embodies views expressed in the conceptual framework (Blikstein and Cavallo, 2003; Cavallo, 2004) on the ecological growth of educational systems. Linked to, and flowing from the Christian view of human custodianship of nature, is metaphoric patterning relating to the Project participants as pioneer farmers. Such patterning is entwined with the image of participants as the farmer in the Parable of the Sower in the Bible. Just as the sower in the Bible becomes a metaphor for Christian disciples who convert and save the heathen, so also, the sower becomes a metaphor for the participants in the study who are tasked with converting ‘unbelievers’ and thus saving the educational system.

This endeavour takes on the form of a journey. The journey is undertaken under a banner – that of ‘converting’ those opposed or neutral towards the Project. Metaphoric patterning related to journeying (4.3.5.3) suggests that the course of the Project is a journey. Although participants in the Project set the course and seek to steer the implementation and further development of the Project in the planned direction, unanticipated obstacles slow down the progress of the journey and eventually bring the Project to a cul-de-sac or ‘dead end’ in the road. At the heart of such patterning lies an absence. Metaphors of journeying, highly standardised metaphors with a fairly narrow range of strong implicatures (Sperber and Wilson, 1995), routinely implicate the traversal of physical space from a specific place of origin to a specific destination. The patterning relating to journeying in the case of the Project is characterised by the absence of arrival at a destination. The alternate translation of the Afrikaans term “doodgeeloop”, as indicated in Chapter 4, is the English expression “fizzled out”. It is this meaning of the term that is taken up in the metaphoric patterning surrounding energy.

Such patterning (4.3.5.4) embodies the growing sophistication in terms of the implementation and sustainability of the Project. It is captured in imagery which progresses from fire to electricity. The imagery thus figured forth relates specifically to the energising of the system by individual participants. But energy figured forth in this way is incapable of driving the project forward, and it seems as if the Project is doomed to ‘fizzle out’. Enter nuclear fusion. Imagery relating to this energy source emphasises the fact that nuclear fusion is a process that is internal to (potentially all) atoms and that it makes use of the massive potential for energy that lies dormant within all atoms. Such imagery provides implicatures relating to the massive energy which lies dormant within each of the participant teachers in the Project. If such energy can be released in sufficiently large numbers of participants, then the Project as a whole will be re-energised and driven towards the originally determined destination of the

journey. This metaphoric patterning presents a visualisation which corresponds well with Fullan's (2005) views on the pivotal role played by systems thinkers and actors in ensuring the sustainability of complex educational systems. Such systems thinkers-in-action transform the system as a whole by subjecting it to cyclical energising. In essence, such patterning encapsulates Heifetz's (2004) characterisation of an adaptive challenge as an enterprise in which the people with the problem are the problem – and also the solution (Fullan, 2005, p.45).

Taken together metaphoric patterning in participant narratives, represent a religiously, socially and culturally defined 'meta-narrative' that takes the form of a 'meta-parable'. Such a 'meta-parable' captures study participants' integration of all influences on the implementation and sustainability of the CALIS Project, within the context of a religiously, socially and culturally mediated reality. Frick (1996) errs when he suggests that teachers should select the best of culture, and make it available to students as they guide their learning. Culture will not be 'selected' – it is woven into the very fabric of everything we know and believe.

In an attempt at capturing the 'inclusiveness' of learning environments, Blikstein and Cavallo (2003, online) argue that learning atmospheres surround learning environments and encompass 'entities' such as generative spaces, multiple expressive media and relationship building. The problem here is that the metaphor underlying this argument reverts to imagery associated with the discrete entities of Newtonian physics. The inclusion of an 'entity' entitled 'relationship building' attempts to include affective functionality in the 'learning atmosphere', but conceptions such as 'entities' and 'atmospheres' serve to alienate us from a world and reality which is shaped, in large part, by our own religious, social and cultural construction.

5.3 Synthesis

5.3.1 Summary of findings

The narratives produced by participants in this study provide evidence which suggests that influences on the implementation for sustainability on the CALIS Project can, in fact, be identified on various structural levels of the educational system, as suggested by Mooij and Smeets (2001). Furthermore, there is enough evidence in the literature on this topic to support such suggestions. The problem with much of the existing literature on the topic, however, is that, in the final analysis, it proceeds from the implicit assumption that individual influences

are discreet entities. As such, the literature proposes a taxonomic approach to investigating the sustainability of computer-integrated education. Paradoxically, the complex systemic nature of educational systems, so well documented and debated in the wider literature involving educational practice generally, is virtually ignored in literature relating to computer-integrated education.

The findings of this study thus endorse a number of propositions expressed in the conceptual framework concerning the implementation of computer-integrated education projects with a view to ensuring sustainability.

1. It is not only the generic personal characteristics possessed by teachers involved in the project that are important; rather there are very specific characteristics associated with participants at all structural levels of the system that need to be taken cognisance of. This is to be expected in complex systems where functional specialisation in integral smaller components of the system enables system-wide functionality.
2. Programmatic planning and implementation of such projects needs to be informed by a systems approach. Such an approach is informed by the recognition that computer-integrated education projects are implemented in a dynamic, complex educational system characterised by unique local host environments and ecological growth patterns. This implies that implementation will be context-specific and that unique, complex feedback systems will stimulate ecological growth of the project along unanticipated trajectories. Far from implying chaos, the implementation of the project needs to guarantee the maintenance of the resulting system on the boundary between over-regulation and implosion. In the case of dynamic, complex educational systems, this can be achieved by growing large numbers of leaders who are systems- thinkers-in- action. Such leaders must actively pursue Fullan's eight essential elements of sustainability at all levels of the system. Only then, can context at all levels of the system be changed. Such context includes institutional and system-wide cultures, defined by Fullan (2005) as that which we (as participants, institutions, systems) agree on as being true.
3. The availability of physical resources, most notably funding, remains a crucial aspect of implementation and sustainability, but it cannot be seen in isolation. The availability of resources is inextricably tied up with: the personal characteristics possessed by participants in the project; the programmatic involvement of

communities in which such projects are implemented; the establishment of public-private partnerships; and the vagaries of historical, economic, technological and political processes that characterise the larger systems within which the educational system functions.

4. 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.

Thus, the findings of this study suggest that the implementation and sustainability of computer-integrated education projects needs to be informed by a systems approach. Such an approach includes conceptions of unique host environments, ecological growth patterns and a systems definition of sustainability. This approach is adequately captured in the conceptual framework of the study.

But participant narratives produce evidence of further influences on the implementation and sustainability of computer-integrated projects not fully accounted for in the conceptual framework, as indicated below.

5.3.2 Anomalies and differences between findings and the literature

The conceptual framework presented in Chapter 2 incorporates concepts drawn from theories relating to complexity, systems, autopoietic and autonomous systems, and complex educational systems. As indicated above, findings produced from participant narratives provide support for these concepts. But findings also provide evidence for a number of metaphoric patterning across narratives. As indicated above, the traditional approach to metaphor interpretation (Lakoff and Johnson, 1980) is precluded in favour of the interpretation of metaphor proposed by Relevance Theory (Sperber and Wilson, 1995; Pilkington, 2000). The reason for this decision is simply the fact that the latter theory proposes an interpretation of metaphor consonant with the plurality and complexity of educational systems, as encapsulated in the existing conceptual framework. Relevance Theory provides a tool with which metaphoric patterning in the narratives can be unlocked, in order to provide access to a socially, religiously and culturally defined 'meta-narrative' that situates

systems influences, previously identified, within a wider anthropomorphic context. Given this insight, the conceptual framework may be updated, as indicated below.

5.3.3 Updated conceptual framework

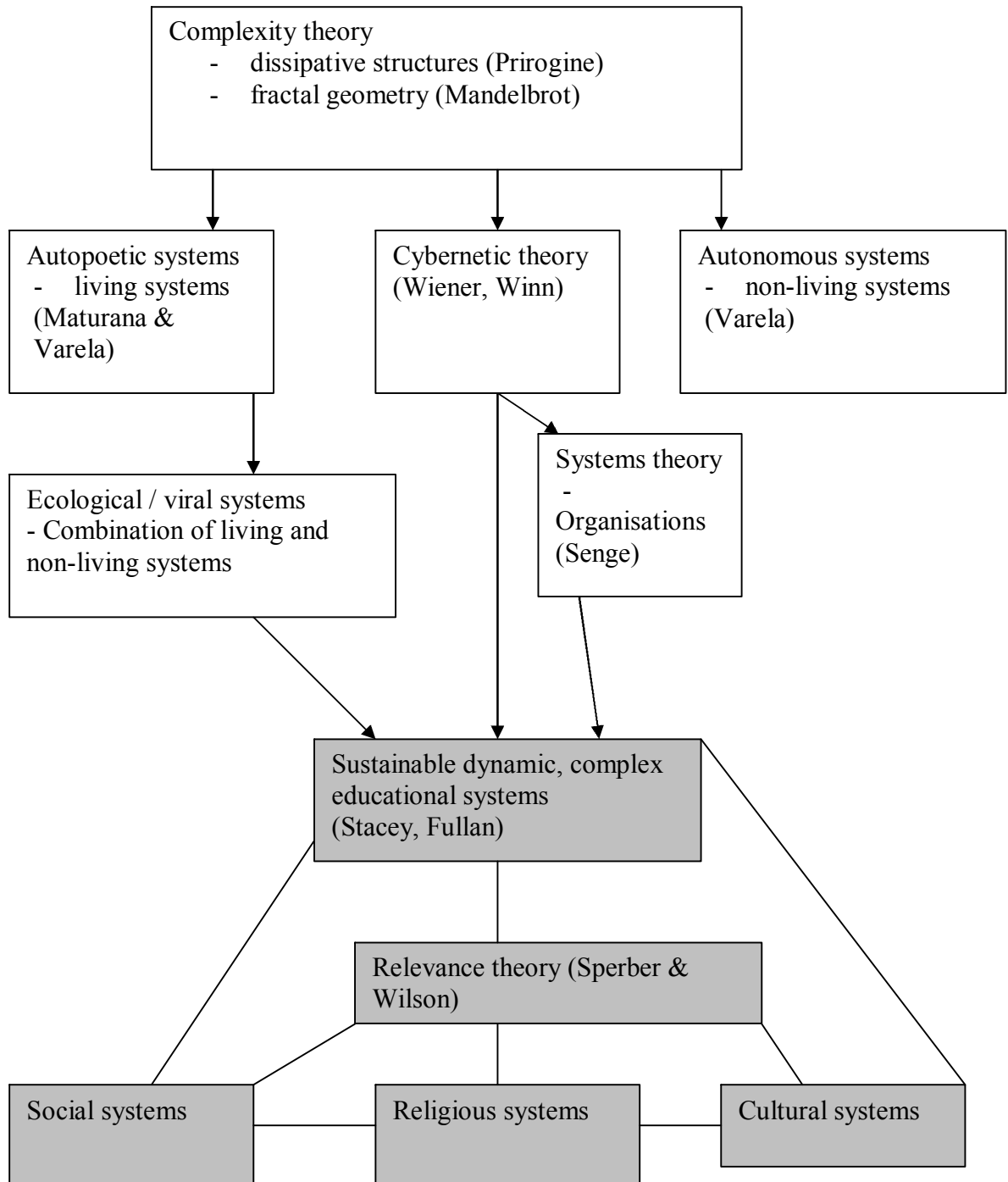


Figure 2: Updated Conceptual Framework

5.4 Reflection

5.4.1 Methodological reflection

From the outset it was clear to me that the methodological approach to the study would have to be philosophically consonant with a broadly postmodernist philosophy. In this regard, a qualitative research approach was adopted. Initially, having conducted exploratory reading on the topic of research design, it appeared to me that a case study design would provide me with the opportunity of utilising instruments which would provide the necessary data relating to the research questions that I had formulated.

On conducting and analysing the first interview, however, it became apparent to me that I would have to adapt my approach in a number of ways. Firstly, I realised that the passage of time (virtually ten years since the Project had been officially terminated) had meant that all of the documentation regarding the Project had been lost. Also, processes of erosion and accrual relating to physical infrastructure had been subjected to a myriad of influences from many quarters over a period of ten years. It would thus be impossible to separate out physical site-based influences brought about by the Project specifically.

Secondly, on conducting and analysing the first interview, it became apparent to me that the semi-structured (English medium) interview (Appendix B) that I had envisaged would have to be discarded in favour of an eliciting of narratives from participants in the language of their choice. In this way, participants would not be prompted to respond to specific questions, thereby precluding mention of influences on the Project not foreseen by myself. An examination of the literature on narrative analysis and life history research provided support for this perception. Such narratives would be supplemented by the keeping of a research journal which would provide an insight into the way in which I, constructed as I am by my own experiences and views, conducted the research process.

Thirdly, further analysis of participant narratives revealed metaphoric patterning across narratives. It became apparent to me that such patterning would have to be subjected to further analysis within an acceptable theoretical framework. I was aware of the fact that Relevance Theory (Sperber and Wilson, 1995) provided an account of metaphor interpretation within the broader framework of a pragmatic inferential account of utterance interpretation. This particular approach to metaphor interpretation is consonant with the larger aims of this study. On the one hand, analysis takes place on the level of utterances rather than

the written sentence. On the other hand, the Theory proposes metaphor usage as an integral part of everyday communication, and not as a special kind of language usage, as is suggested by the 'literal-figurative' dichotomy. Relevance Theory would thus provide a key to analysing the integral nature of metaphoric patterning to the narrative communication produced by participants. The analysis thus conducted proved to be justified by providing insight into the existence of a socially, religiously and culturally defined 'meta-narrative' that integrates all other influences on the Project.

As envisaged in Chapter 3, the findings in this study can be generalised to the theoretical position adopted in the conceptual framework. Although all host environments are unique in terms of context, all educational systems and the projects implemented in them are dynamic, complex systems and, as such, are governed by the same functional characteristics. For this reason, an examination of the local context within which an individual project is implemented will have very limited value, unless such an examination is situated within an examination of the larger systemic context.

5.4.2 Substantive reflection

Although numerous studies document the implementation of computer-integrated education projects, many of these are informed by a quantitative methodology, which leads to a taxonomic approach to the elucidation of relevant influences on the project. As a result, influences are, more often than not presented as discreet, individual forces, rather than interrelated, cross-structural co-determinants of successful implementation and sustainability.

Even in studies underpinned by qualitative methodology, failure to acknowledge the dynamic, complex nature of the educational system in which these projects are implemented leads to simplistic conceptions of sustainability as being determined by the ability of the project to persist over time, as a result of the availability of physical resources. Sustainability, in the case of computer-integrated education projects needs to be seen as a quality relating to these projects within the educational system as a whole, rather than a quality relating to individual projects, specifically.

Furthermore, as Selwyn (2000) cautions, we ignore the social, religious and cultural situatedness of such projects to our peril. This study provides some evidence in support of his claim that such situatedness will, in the final analysis, be a far more powerful influence on the implementation and sustainability of such projects than any number of 'nay saying' politicians.

5.4.3 Scientific reflection

This study has contributed to the scientific body of knowledge in the following ways.

1. A conceptual framework is suggested, within which postmodernist research relating to computer-integrated education can be conducted.
2. The study suggests further that influences on the implementation and sustainability of computer-integrated education projects have to be contemplated from a systems perspective, where such projects are recognised as being implemented in a dynamic, complex educational system. Failure to do so will result in taxonomies of influences that do not reflect the interrelatedness of influences across all structural levels of the system.
3. Social, religious and cultural ‘meta-narratives’ encompass and integrate all other influences on implementation and sustainability. Failure to take cognisance of ‘meta-narratives’ will lead to a simplified and incomplete understanding of the sustainability of such projects.

Given the insights mentioned above, recommendations regarding policy and practice (5.5.1), and recommendations regarding further research (5.5.2), are made in the relevant sections below.

5.4.4 Reflection on exploratory journey

Just as the metaphorical journey presented in participant narratives reflects the absence of arrival at, or perpetual distance from, the destination, so also this study is the beginning of a journey, the course and destination of which are unknown. What is known are the processes and characteristics of the system within which further research is to be conducted?

This study has elucidated the processes and characteristics of dynamic, complex educational systems, involving unique host environments, ecological growth, indeterminate lines of development and unknown end-states. An awareness of such characteristics and processes has sensitised me to the importance of educational research approaches that include plurality, complexity, flexibility and dynamism. Such ‘openness’, however, needs to be balanced by attention to rigour, and constant reflection on what it means for knowledge to be accepted as ‘truthful’ or ‘believable’.

5.5 Recommendations

5.5.1 Recommendations for policy and practice

Based on the findings presented above, the following recommendations for policy and practice are made regarding the implementation and sustainability of computer-integrated education projects.

1. It is not only the generic personal characteristics possessed by teachers involved in the project that are important; rather there are very specific characteristics associated with participants at all structural levels of the system that need to be taken cognisance of. This study indicates that participants at national, regional and project management levels need, critically, to possess the following characteristics. Firstly, they need the ability to envision the project within its complex systemic situatedness, and the ability to communicate this vision. Secondly, they need to have extensive managerial experience. Thirdly, and perhaps most importantly, they need to be able to create and energise leaders at all levels of the system, which are also systems-thinkers-in-action. Implementers of the project, at the structural level of the project, need to possess a passion for the goals of the project. This passion has to be supplemented by the necessary drive and capacity for hard work. School principals and school managers need to possess similar qualities, as well as managerial capabilities. Teachers who implement the project in their classrooms should, ideally be people who: are naturally inquisitive; have a high tolerance for change and uncertainty; are driven to succeed; are passionate about the enterprise; and who seek answers to educational challenges.
2. Programmatic planning and implementation of such projects needs to be informed by a systems approach. Such an approach is informed by the recognition that computer-integrated education projects are implemented in a dynamic, complex educational system characterised by unique local host environments and ecological growth patterns. This implies that implementation will be context-specific and that unique, complex feedback systems will stimulate ecological growth of the project along unanticipated trajectories. Far from implying chaos, the implementation of the project needs to guarantee the maintenance of the resulting system on the boundary between over-regulation and implosion. In the case of dynamic, complex educational systems, this can be achieved by growing large numbers of leaders who are systems-thinkers-in-action. Such leaders must actively pursue Fullan's eight essential elements of

sustainability at all levels of the system. Only then, can context at all levels of the system be changed. Such context includes institutional and system-wide cultures, defined by Fullan (2005) as that which we (as participants, institutions, systems) agree on as being true.

3. The availability of physical resources, most notably funding, remains a crucial aspect of implementation and sustainability, but it cannot be seen in isolation. The availability of resources is inextricably tied up with: the personal characteristics possessed by participants in the project; the programmatic involvement of communities in which such projects are implemented; the establishment of public-private partnerships; and the vagaries of historical, economic, technological and political processes that characterise the larger systems within which the educational system functions.
4. 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. Implementation of computer-integrated education projects must ensure that cognisance is taken of the social, religious and cultural context that characterises not only individual institutions, but also the system as a whole. Such contexts powerfully influence the sustainability of such projects by providing 'meta-narratives' that integrate all other influences in mutually intelligible, and mutually accepted systems of belief as to what constitutes truth.

5.5.2 Recommendations for further research

The influence of close personal relationships across contiguous institutions is not contemplated in the literature as a contributory influence to the successful integration and sustainability of computers in classroom practice. Yet, the findings of this study suggest that the influence of such relationships should be examined more closely.

Another suggestion related to further research springs directly from the last recommendation made in the previous section. More research is required into the ways in which social, religious and cultural 'meta-narratives' integrate influences on the implementation and

sustainability of such projects. Concomitantly, research needs to be conducted into the methodological processes by which evidence of such meta-narratives' is obtained. In this study metaphorical patterning provides some evidence of such 'meta-narratives' but a more inclusive study of social, religious and cultural artefacts need to be undertaken (in specific contexts) in order to provide richer evidence of the kind of integration of influences envisaged in this study. Such evidence could be accessed by conducting research into influences on the sustainability of the CALIS Project in individual institutions where the Project is recognised as having been sustained.

A further suggestion related to further research involves the view that the educational system within which a project is implemented should be characterised by leaders at all levels of the system who are also systems-thinkers-in-action. A detailed evaluation of what constitutes such systems 'thinking' and such systems 'action' in specific institutional settings will provide tangible models which can be adapted to inform programme planning, staff development and best practice in a far more concrete fashion.

Perhaps the most promising avenue of research opened up by this study is an investigation of institution-specific influences on the sustainability of a computer-integrated education project. In this respect, data could be gathered relating to specific institutions involved in the CALIS Project, with a view to identifying influences on sustainability that arise in particular contexts.

5.6 Conclusion

This investigation into a computer-integrated education project took place in a unique host environment, characterised by the abrupt withdrawal of government support at the exact moment when it seemed as if the project was set to grow very quickly. According to accepted accounts of sustainability, the project should have come to an abrupt end at that point. But such an account of sustainability views influences as discreet, individual forces. In contrast, a view of the education system as dynamic, complex and integrally connected to larger systems, predicts that ecological growth takes place in environments where sustainability is a function of such dynamism and complexity. For this reason, many schools continued using computers in curriculum-integrated ways. Such usage evolved, over time, into practices, some of which the original instigators of the project could not have foreseen. At the heart of the complex systems approach to technology in education lies a radically new mindset: the ability to be surrounded by indeterminacy whilst being content with this state of affairs. This contentment does not spring from a cynical acceptance of the perception that planning and action are futile – rather it informs a belief in the efficacy of planning and action in the face of incomplete

knowledge. This is what systems-thinkers-in-action believe and do. The rest of us are capable of similar beliefs and actions.