UNIVERSITY OF SOUTHAMPTON

Faculty of Law, Arts and Social Sciences

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Towards a grounded theory of computer-assisted assessment uptake in UK universities

by

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ABSTRACT

FACULTY OF LAW ARTS AND SOCIAL SCIENCES

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TOWARDS A GROUNDED THEORY OF COMPUTER-ASSISTED ASSESSMENT UPTAKE IN UK UNIVERSITIES

By William Ivan Warburton

Universities are under pressure to justify the time and expense expended by students in obtaining a degree which has stimulated interest in measuring more formally how learning outcomes have been met by students. The 1997 NCHE (Dearing) Report called for improvements in higher education (HE) assessment practice and while assessment is widely regarded as the critical catalyst for student learning it is often in practice relegated to an afterthought. The potential for information and communications technology (ICT) to automate aspects of learning and teaching is widely acknowledged although promised productivity benefits have been slow to appear.

Computer-assisted assessment (CAA) is seen by many as one way of meeting these conflicting demands. CAA has considerable potential both to ease the assessment load and to provide innovative and powerful modes of assessment. Moreover, as the use of ICT increases there may be 'inherent difficulties in teaching and learning online and assessing on paper'. Given the importance of assessment activities in higher education, the level of current interest in CAA and widespread disagreement about how it should be implemented, there is a clear need for rigorous, grounded models of good practice.

A national survey of CAA practice was conducted using online tools and interviews with enthusiast and early adopting CAA experts and practitioners throughout the UK which explored the critical factors associated with the uptake and embedding of CAA. A grounded theory analysis of the interview and survey data was carried out and a theory of dual path CAA uptake in universities emerged from which three models of uptake were derived. These were validated against qualitative data obtained from a final set of interviews and by triangulation with survey data from the 2003/4 UK CAA survey.

Tutors' motivations and perceptions of risk influence the way they use CAA and this is significant in credit-bearing applications where non-optimal outcomes have long lasting effects on uptake. Institutions can benefit from using project risk management techniques to manage these risks.

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DECLARATION OF AUTHORSHIP

I, WILLIAM IVAN WARBURTON declare that the thesis entitled

TOWARDS A GROUNDED THEORY OF COMPUTER-ASSISTED ASSESSMENT UPTAKE IN UK HIGHER EDUCATION

and the work presented in it are my own. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a research degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
- where I have quoted from the work of others, this the source is always given. With the exception of such quotations, this thesis is entirely my own work;
- I have acknowledged all main sources of help;
- where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- parts of this work have been published as:

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WARBURTON, W. (2005) *What are grounded theories made of?* [online] available: www.eprints.soton.ac.uk/16340/ [last accessed 28.7.05]

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Signed ______________________________

Date ______________________________

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1 Introduction

This chapter is the first half of the background theory section, including statements of why the problem is worthy of study at doctoral level, the context of computer-assisted assessment (CAA) found at the outset of the research, the aims of the study undertaken and a summary of the dissertation's structure. The second half of the background theory section consists of a literature review (chapter 2).

1.1 The 'itch' that prompted this research

Having worked in the field of learning technology in both the commercial and public sectors, I had become sensitised to factors underlying 'good' and 'bad' applications of learning technology (Warburton, 2002). In November 2002 I started work as a CAA Officer at the University of Southampton where a principle focus of my job was to implement Questionmark Computing's *Perception™* CAA system. I brought with me a long-standing interest in identifying and employing strategies that promoted 'successful' outcomes both in terms of making learning technology easy to use and in identifying suitable applications. It seemed to me that CAA was an emergent field of expertise with similarities to other learning technologies but its own unique complexities. Being unaware of any scalable models for implementing CAA on an institutional scale, I wanted to understand how to make good, informed decisions about implementing CAA at the University of Southampton.

The notion that CAA uptake is lower than expected emerged during an unrecorded conversation with a CAA user who observed that the uptake of CAA within his department was very much lower than might be expected by enthusiasts and early adopters given the prima facie potential for securing productivity and pedagogic benefits (see for example Bull and McKenna, 2004). He cited anecdotal evidence from colleagues to the effect that this was largely due to time pressures and he argued that CAA uptake lagged expectations because tutors do not have time to use it and that if sufficient time could be made available then uptake might match expectations.

This made me wonder what the most important obstacles to uptake were. An initial analysis of the literature suggested many reasons why tutors start using, continue to use, stop using or never use CAA. A complex picture began to emerge in which institutional contexts and tutors' practice varied so widely that it was impossible to say which factors were most significant in these decisions. For example it seemed that CAA was not used more widely because it was thought inappropriate for assessing university students, which left the issue of what could be done to promote its use where it is appropriate.

1.2 Rationale

The post-war expansion of the education system fuelled a debate about the dilution of academic standards in universities which was reignited in the 1990s following the overnight doubling of the number of UK universities when polytechnic institutions were given their own degree awarding powers 1992 (Barnett, 1997; Biggs, 1999; Bocock and Watson, 1994; Shattock, 2003). Assessment practice has come under increased scrutiny amid suspicions that annual increases in GCSE pass rates and the numbers of undergraduates achieving good degrees was at the expense of falling academic standards. This is called 'grade inflation' by employer's associations such as the Institute of Directors (IoD) and some sections of the press (IoD, 2001; Lea, 2002; THES, 2004a) or less formally 'dumbing down' (see, for example, BBC News, 2003; Daily Mail, 2005; The Conservative Party, 2003; THES, 2004b).

This concern with assessment practice presents an apparent paradox because as a nation we have never been so heavily assessed. All school-age students are assessed summatively at Key Stages 1 -3 while most pupils take GCSEs or some other examination at the end of their school careers (QCA, 2005). The Quality Assurance Agency (QAA) and the Dearing report both called for more frequent assessment during higher education (HE) courses (NICHE, 1997; QAA, 2000) and the shift towards continuous assessment of coursework at every level of the education system has increased the frequency of testing (Biggs, 1999; THES, 2004c).

Strident demands from quality watchdogs (self-appointed and otherwise) for improvements in learning and teaching practice coupled with requirements for learning achievements to be more stringently validated have directly driven a trend towards more frequent assessment which was reflected in the Dearing Report (NICHE, 1997). Changes in the dynamics and demography of Western societies resulted in an increasing emphasis on widening participation (WP) and lifelong learning which indirectly fuelled the increased volume of assessment activities (JISC, 2003a; Linn, 1998).

This trend towards increased frequency of testing comes at a time of static or diminishing resources in higher education (see, for example, Philo and Miller, 2000) and begs the question of how the growing assessment burden can be managed by tutors in higher education who are assessing higher order learning outcomes without necessarily being assessment experts themselves (Boyle and O'Hare, 2003; Elton and Johnston, 2002; Race, 1993).

Claims that CAA offers pedagogic and productivity benefits (Bull, Conole, Davis, White, Danson and Sclater, 2002; Mills, Potenza, Fremer and Ward, 2002; Peat and Franklin, 2002) raise the prospect of reductions in tutors' assessment burden. Moreover, some analysts point out that the global shift from paper to electronic media will sustain a trend towards assessment materials being delivered electronically (Bennett, 2002a).

In addition technologies are constantly changing and hence the factors which promote or inhibit the use of CAA will change accordingly. Therefore I wanted to produce a model of CAA uptake that would allow for the dynamic nature of these factors and which could be general enough to be used in planning the implementation of CAA in other universities.

The primary question asked in this thesis is why, given the *prima facie* advantages, the uptake of computer-assisted assessment (CAA) is not higher in UK universities. A secondary question arose of what can be done to ensure that the benefits of CAA are secured where appropriate. The research problem is framed as how to understand the factors underlying uptake, sub-questions focus the investigation on underlying mechanisms, with the aim of modelling CAA uptake. Metrics for CAA uptake would illustrate the merits of differing CAA practices.

1.3 The research problem

When asked to think about assessment, most people talk about 'exams' which are the summative tests at the end of courses that validate student attainment of learning objectives. In fact society is permeated by assessment activities of all kinds which can be differentiated both by the significance of the outcome and by the level of reward. The significance of testing varies according to relative difficulty and the degree of selection involved whilst the rewards of testing vary according to resultant improvements in social, professional or financial status. Leisure aspects of testing are at one extreme of the reward continuum and the testing undergone by candidates for professional qualifications is at the other end (Figure 1).

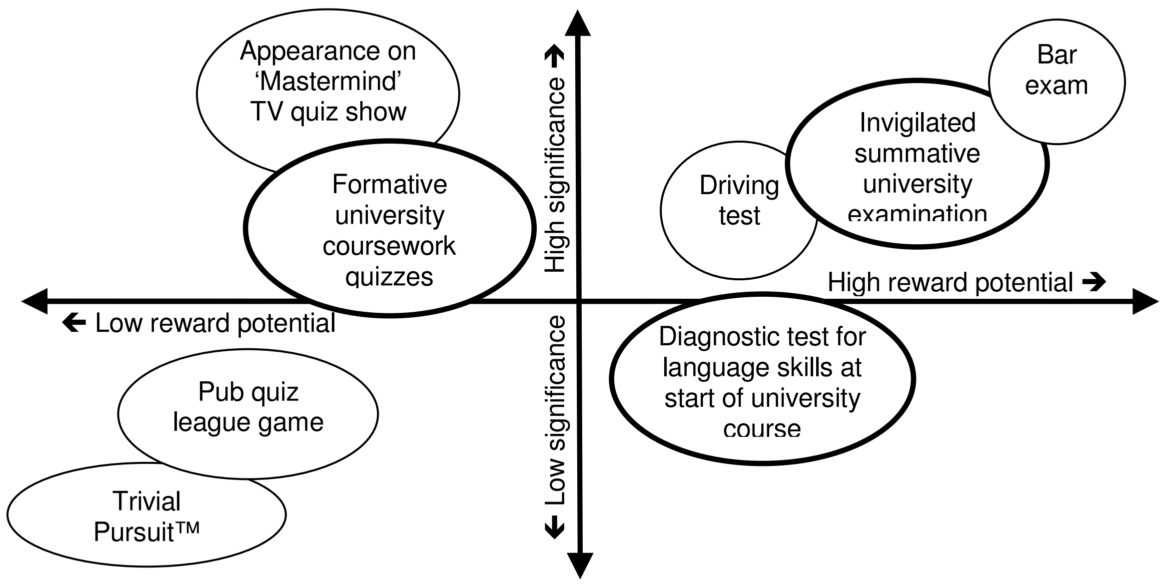

Figure 1- Common assessment activities according by significance and reward potential

Assessment provides a yardstick for comparing the abilities of university graduates. Learners in higher education principally justify their investment in terms of obtaining the best qualifications they can and it has long been recognised that students take a utilitarian approach to their studies by concentrating their efforts on course assessment requirements. An eminent scholar wrote of his experience before World War I:

> It astonished me to find … the ambitions of ninety out of every hundred of my fellow-undergraduates were crude and calculating. They were interested in one thing only – in getting the best possible degree by the shortest possible method (Sir Herbert Read quoted by Lee, 2005)

However, the traditional model of lecture-based higher education teaching is widely supplemented by formative assessment which can help students engage with learning and this is another obvious way in which CAA can provide productivity benefits (Sclater, Conole, Warburton, Whitelock and Harvey, forthcoming).

The increasing assessment load has done little to allay fears that widening participation (WP) has led to a dilution of academic standards in higher education (BBC News, 2004a; THES, 2004a; 2004d). This was recently highlighted by a televised documentary that depicted academics being pressured to pass sub-standard undergraduate work (BBC, 2005). These fears have been underlined by recent national press coverage of increases in the proportion of first class and upper-second class degrees awarded by universities in the UK. This puts pressure on academics to justify their practice and upon learners to secure the best outcome in terms of qualifications.

In order to understand the mechanisms underlying the uptake of CAA the research problem focussed on understanding existing assessment practice. This required a grasp of the top-down requirements for institutional assessment practice and a bottom-up appreciation of how learners engage with their courses through assessment activities.

1.4 Context of the research

The report of the National Committee of Inquiry into Higher Education (NCIHE) entitled *Higher Education in the Learning Society* and known as the Dearing report (NICHE, 1997) represented a watershed and has in many ways created the current higher education landscape. It has arguably done more than any other single document to enshrine assessment activities as the most important thing that universities do and created a blueprint for higher education in the 21st century for the UK (Biggs, 1999).

The Dearing committee made nearly a hundred recommendations. Some of the most relevant for this study were measures to widen participation by uncapping aggregate student numbers, facilitating access for students with disabilities and replacing the old notion of education as a single event' (Chapters 6 and 7, NICHE, 1997).

The Dearing Committee's report recognised that the UK no longer enjoyed the privilege of competing internationally on the grounds of a better-educated workforce (Annex A to the terms of reference, NICHE, 1997), It recognised that links with further education (FE) were of growing importance and formally identified technology as a driver for 'new forms of teaching and learning' (Annex A to the terms of reference NICHE, 1997), particularly where higher education 'is increasingly delivered in the work-place and in the home through distance-learning'. The report saw a competitive relationship between universities in terms of students' increasing choice in matters of mode and location of study, particularly in the light of advances in distance learning (Annex A to the terms of reference NICHE, 1997). It established the principle that notwithstanding these pressures for increased uptake of higher education, 'standards of degrees and other higher education qualifications should be at least maintained and assured' and that 'the effectiveness of teaching and learning should be enhanced' (Terms of reference, NICHE, 1997). Concerns about the relevance of higher education to the needs of the workplace were recognised (Terms of reference, NICHE, 1997). In other words it embraced widening participation and established a shift in emphasis from the assessment of quality *per se* to standards-based measures of quality which was ratified with the creation of the QAA (Lomas and Tomlinson, 2000).

The report advised universities to implement learning and teaching strategies that maximised students' learning. It recommended that staff and students alike should be trained in communications and information technology (C&IT, now known as ICT) and that staff development programmes should be nationally accredited by the Institute for Learning and Teaching in Higher Education (ILTHE), which was tasked with kitemarking and coordinating the development of high quality computer-based learning materials (Chapter 8, NICHE, 1997). The ILTHE was subsequently replaced by the higher education academy (HEA).

Dearing recommended that student attainment should be assessed more frequently and according to formal statements of intended outcomes in terms of expected knowledge, understanding, key skills, cognitive and metacognitive skills. No recommendation was made as to how these outcomes were to be tested in students (Chapter 9, NICHE, 1997). The remit of the Quality Assurance Agency (QAA) was adjusted to include quality assurance exercises, standards verification and maintenance of the qualifications framework. These were enshrined in a code of practice every institution was required to adopt by 2001/02, as a condition of continued public funding (Chapter 10, NICHE, 1997).

The Report did much to accelerate the uptake of ICT in higher education by recommending that 'all higher education institutions in the UK should have in place overarching communications and information strategies by 1999/2000' (recommendation 41, NICHE, 1997) . It aimed to promote this by encouraging universities to develop managers who 'combine a deep understanding of Communications and Information Technology with senior management experience' (recommendation 42, NICHE, 1997). The benefits of C&IT were to be secured by the general provision of high capacity network connectivity and all students were expected to have open access to a networked computer. The report anticipated that all students would be 'required to have access to their own portable computer' by 2005/06 (recommendation 42, NICHE, 1997).

Dearing expected all full-time academics with teaching responsibilities to attain at least associate membership of the ILTHE to complete their initial probation (Chapter 14, NICHE, 1997). The report called for increased transparency in handling student appeals and complaints (Chapter 15, NICHE, 1997). The funding model was to change in order to follow student preference rather than to simply maintain existing funding arrangements (Chapter 19, NICHE, 1997).

Dearing signalled a shift across the sector towards a market-driven funding model. This change in resource allocation sharpened the competitive pressures on universities and made it more important for universities to differentiate themselves with a 'competitive edge' in the emerging higher education market.

1.5 Why this research is important

The topic was considered worthy of doctoral research in extrinsic and intrinsic terms. Extrinsic worth lay in producing a theory of CAA uptake that could be used to improve assessment practice in institutions and intrinsic value was in applying doctoral level analytic, synthetic and evaluative skills to a large and complex research problem.

Widening participation in school-age education forced schools in the UK to undergo a shift from narrow undifferentiated 'Grammar School' curricula to differentiated curricula that cater for the needs of all learners (Goodson, 1993; Ross, 2000). This was followed by similar changes in further education (FE) and now in higher education where students from non-traditional backgrounds form an increasing proportion of student intakes. Assessment is a vital part of the learning process and is also the primary means by which the effectiveness of the teaching and learning process is measured. The possible contribution of diagnostic and formative CAA applications is an obvious area of interest. In a context of widening participation there is enormous pressure on academics to do more without increased funding in real terms (Sanders, 2004), while at the same time students are entering university with increased expectations of support from their tutors (THES, 1998). Universities are also under increasing external pressure from students, parents and employers to justify the time and expense of getting a degree (THES, 2005a; 2005b). Detailed summative assessment transcripts are one way to demonstrate the 'added value' of a university education (THES, 2004d).

Although the higher education sector is regulated by the Qualifications and Assessment Agency (QAA), universities do not work to a shared 'national curriculum', nor do they have the same level of detailed guidance that is provided for examiners in the school and FE sectors. However, universities host the equivalent of OfSTED inspections - the teaching quality assurance (TQA) exercise - and are under competitive pressures as never before to demonstrate that they represent value for money in terms of their research output according to the Higher Education Council for England's (HEFCE's) five-yearly research assessment exercise (RAE). At the same time universities are also under great pressure to demonstrate the value they add to their students (THES, 2002a). Universities are increasingly vulnerable to litigation from disappointed students (THES, 2003; 2004e; 2004f). Much of this anxiety is traceable to the upheaval endemic in widening participation and seems related to calls for assessment practice to become more transparent that were reflected by Dearing (Chapter 15, Dearing, 1997).

Much of the interest in CAA centres on expectations that it can help to relieve the academic marking load caused by rising student cohort numbers (HESA, 2004). It is difficult to dissociate this from expectations that universities will comply with increasing demands for improvements to render it more appropriate to the needs of students and more rigorous in terms of quality assurance so that, for example, the best graduates are clearly distinguishable (Dearing, 1997). These influences, combined with the pervasiveness of technology in working life as paper-based processes are replaced by computer-based equivalents, make it increasingly difficult to justify doing assessment on paper. There have been, for example, demands that technology based skills should be assessed using technology, as has been the case with commercial information and communications technology (ICT) certifications for many years. Some CAA experts believe assessment activities will be automated in the medium term irrespective of short term success or failure. Bennett called this 'the onward march of technology':

> Increasingly, people have to know how to use technology to work and to learn. Thus, technology is becoming a substantive requirement in its own right. The emergence of technology as a necessary skill means there will be tests of it. For those who specialize in computing, such tests have become common for certifying job proficiency… But as working and learning begin to require technology competence of almost everyone, assessing these skills will become routine. (Bennett, 2002a p. 8)

Although the use of technology to facilitate assessment has grown in recent years, an initial scan of the literature found little formal evaluation of the impact of CAA in higher education. However, two national surveys of CAA use (Bull, 1999; Stephens and Mascia, 1997) provided measures of the degree of penetration achieved by CAA in higher education and it was thought that this research could make a timely contribution to the literature by providing a detailed survey of progress in this fast-changing field.

The Higher Education (HE) sector is characterised by a relative lack of national formal supervision which has made it particularly difficult to assess the contribution made by CAA activities. The evaluation of educational activities is known to be a difficult, contentious matter (Anglin, 1995; Brown, Bull and Pendlebury, 1997) and the difficulty of evaluating the contribution of learning technologies generally is compounded by the complex relationships among factors such as pedagogic context, the maturity of the technology used and the skills of the practitioners (McKenna and Bull, 2000 p. 29). The evaluation of CAA activities presents even greater challenges because the stakes are high and the underlying technologies are relatively immature (Best, 2002; Jones, Barnard, Calder, Scanlon and Thompson, 2000). Moreover, CAA case studies depict a mixed picture of success. Implementing or 'embedding' CAA on an institution-wide scale emerges as a substantial undertaking that brings unique difficulties and needs specialised support. Given this complexity, there is a need to identify what kinds of support are most relevant to the success of CAA applications in higher education and to identify appropriate metrics for evaluating the success of existing CAA applications.

As pressure for more frequent assessment in the school and FE sectors has increased, so too have concerns that the public assessment system is buckling under the load. This has been highlighted by some spectacular failures associated with the use of technology in the public assessment system. The BBC's education correspondent wrote in the aftermath of the resignation of the National Assessment Agency that:

> It is now a commonplace to say that young people in Britain, especially in England, are the most tested anywhere in the world… the average child in England can now expect to sit national tests and exams at the ages of seven, 11, 14, 16, 17 and 18. That is not only a burden on pupils but it also places great demands on those who set, distribute and mark exam papers. Technology is supposed to be making this easier but, when it goes wrong, it multiplies the errors… at present there appears to be a terrible fragility in the testing and marking system. (BBC News, 2004b)

The growth of the internet made it easier for unscrupulous (or naive) students to plagiarise their way to 'success' in terms of completing their degrees (THES, 2005c). The threat has emerged that degrees will be seen as plagiarists' certificates and universities are coming under pressure to demonstrate that graduates can really do what their degree certificates say they can. This issue of 'internal validity' has led to the emergence of detailed assessment transcripts as audit trails (THES, 2004d) and there is obvious scope for this aspect of assessment to be automated (Hare and Waterston, 2003). I wanted with my research to establish the extent to which this threat is being addressed through technology-based approaches to assessment.

1.6 Scope of research

The research aims to address the research question of why uptake is not higher by constructing a model of the processes underlying uptake. It is framed as a study of CAA uptake among tutors in UK universities. National surveys of learning technologists and tutors were conducted which followed on from the 1999 CAA Centre survey (Bull, 1999) and some stakeholder groups were not included. For example, students were not included in the survey and non-adopters were not formally targeted: the responses received were primarily from CAA users and this should be considered when drawing inferences from the findings.

1.7 Outline of dissertation

This thesis is arranged according to the recommendations of Phillips and Pugh (Phillips and Pugh, 1994). They suggest writing in four sections: *background theory* including a relevant and comprehensive literature review, *focal theory* which provides a detailed description of the research problem and its analysis, *data theory* where the research data are analysed and *contribution* where the significance of the findings is discussed and summarised, conclusions drawn and the scale of the contribution is assessed in context with other relevant research (1994 pp. 56-60). These four sections are arranged in traditional chapters (Table 1).

Section	Chapters
I Background theory	1 Introduction; research aims 2 Literature review
II Focal theory	3 Methodology
III Data theory	4 Phase 1 GT data collection & analysis 5 Phase 2 GT data collection & analysis 6 Phase 3 GT data collection & analysis
IV Contribution	7 Discussion

Table 1- Structure of dissertation

This chapter described the first part of the background theory section, including statements of why the problem was of interest, the context of CAA found at the outset of the research, the aims of the study undertaken and an outline of the thesis structure. The next chapter reviews relevant literature found in a search for material pertaining to this research problem. The methodology used in this study constitutes the focal theory section and is described in Chapter 3 where an account is given of the philosophical background which led to the adoption of a grounded theory (GT) methodology. An account is given of the rationale used for selecting a survey approach to the problem and the particular branch of GT methodology used in this study is described. A brief overview is given of the approach taken to the surveys used to collect data and of the analytic process applied to the data which includes a rationale of the approach taken when conducting personal interviews.

The data theory section is written as a narrative where the process of discovering attributes of CAA adoption is described according to the order in which the steps were made. It begins in Chapter 4 with an explanation of the first phase of the GT data collection and analytic coding process. An account is given of the selective coding processes used to generate an early emergent theory of CAA adoption. Chapter 5 provides summaries of the data collected and analysed during the second phase of data collection and analysis, including both iterations of an online UK survey of CAA use in higher education that were undertaken. These are accompanied by analyses of data from other sources including interviews conducted with CAA experts and practitioners. Saturation of categories was deemed to have been achieved during this phase and an account of the selective coding processes used to generate the emergent phase 2 theory of CAA adoption is given. Chapter 6 provides a description of the final phase of data collection and analysis where the emergent theory was tested in interviews with some of the respondents in the first two phases and with others who had not been contacted before.

In the contribution section, Chapter 7 presents findings in the form of a discussion of the substantive theory in context with other surveys and relevant literature. This is followed by reflections on the research process including a discussion of how strengths and weaknesses of the research methodology affect the validity of the emergent theory. Theoretical and methodological contributions are assessed and summarised and some suggestions are made for future work.

2 Literature review

2.1 Introduction

Assessment is widely acknowledged as '*the*' critical catalyst for student learning (Brown et al., 1997; Sclater et al., forthcoming) and there is considerable pressure on higher education (HE) institutions to measure more rigorously the extent to which learning objectives have been met by students (Cooke, 2003; Farrer, 2002; Laurillard, 2002), which has been interpreted as a demand for more frequent assessment. These additional pressures come at a time when financial resources are seen to be static or dwindling (Lee, 2005). The potential for information and communications technology (ICT) to automate aspects of learning and teaching (L&T) in universities is widely acknowledged although promised productivity benefits have been slow to appear (Conole and Dyke, 2004). CAA has the apparent potential to ease tutors' assessment burden and provide innovative and powerful assessment modes of assessment in higher education but it can also contribute to better assuring the quality of learning through detailed assessment transcripts (see, among many others, Brown et al., 1997; Bull and McKenna, 2004). Furthermore as society shifts inexorably towards technology-based practices generally, it may become difficult to defend paper-based assessment practice. In this case, the problem may change from the 'can - and should - CAA be used in this application' to 'when can we do this?' as Bennett (2002b) suggests.

2.2 Method used to conduct initial review

Literature reviews for GT studies differ from those conducted for deductive research. Researchers in the deductive tradition critique existing literature with the aim of identifying deficits to be filled and which focus or inform the research effort (Hart, 1998 pp. 12-14). The essence of GT research is that the researcher has a general interest in some aspect of a field and allows theory to emerge directly from data (Glaser, 1992; Glaser and Strauss, 1967; Strauss and Corbin, 1998a). This review provides an overview of the literature concerning learning technologies, assessment, CAA, computer-based assessment (CBA) and online testing to prepare for an investigation of the critical factors that influence uptake in universities.

It adopts Strauss and Corbin's (1998a) suggestion that researchers should become familiar with the field before beginning data collection. It provides an overview of the literature on assessment practice generally and CAA in particular, in higher education. It examines earlier development and current activities before highlighting possible future developments. Progress made in identifying and addressing critical factors associated with implementing CAA in the context of other learning technology practice across the sector is defined. The influence of critical factors on the uptake of CAA in universities is outlined and current activities and debates are described. A description of possible future directions for CAA in universities is provided. The chapter closes with a summary of the activities carried out in the review. An analysis of the substantive theory in context with more recent literature is given in chapter 7. Although the 'cut-off' date for this initial review was the 2003 CAA Conference after which a grounded theory approach was formally adopted (Ch.3), I had access to early drafts of work which was published later. Strauss and Corbin's plan for literature reviews is shown below as box II (Figure 2). They suggest two main reasons for beginning a review of the literature before starting fieldwork which are directly relevant to this study (1998a pp. 48-52). Firstly, concepts that arise in the literature can be compared with concepts that arise from data and any similarities or differences found can be compared in terms of dimensions and properties. Secondly, familiarity with the literature can sensitise researchers to 'subtle nuances in data', although it must be accepted that it can also 'block creativity'. Other reasons given are:

- a grasp of existing canon can inform speculation about the field of study
- the literature can be treated as a secondary source of data
- the literature can provide questions that comprise a 'launch pad' for the study
- the literature can stimulate thought in the data analysis phase
- the literature can be used to validate theory at the end of the study
- areas for theoretical sampling can be provided by the literature

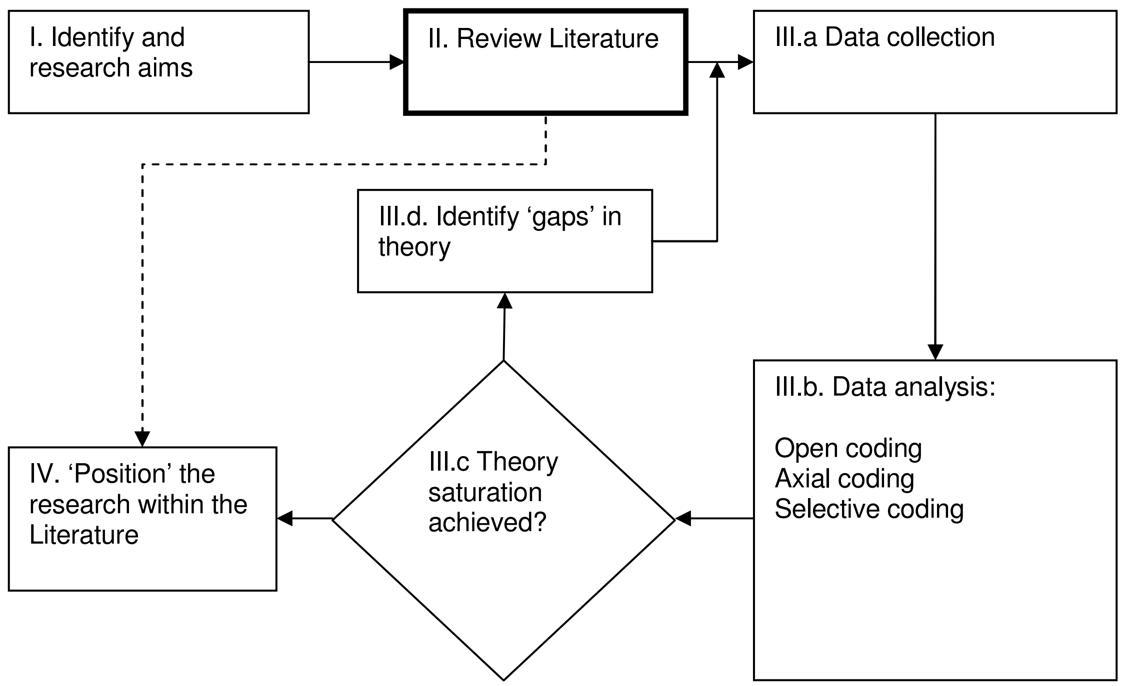

Figure 2- Overview of grounded theory research process (after Harwood, 2002 p. 69)

2.2.1 SCOPE OF THE INITIAL LITERATURE SEARCH

A search was conducted of CAA-related literature from the last decade in order to trace its development from the beginnings of large scale use. Criteria for inclusion were direct or indirect reference to the implementation or evaluation of large scale CAA. Some earlier material was included because it forms the foundation of the literature. Search keywords formulated based upon the topics outlined above were entered (with their acronyms) into a full range of electronic literature indexes, catalogues and search engines. The keywords chosen for the search were 'CAA', 'CBA', 'computer-based assessment', 'computer-assisted assessment', 'on(-)line assessment', 'e(-)assessment' and just 'assessment'. Because managed learning environments include a CAA component, the following terms were also searched for: 'MLE', 'managed learning environment' and because much CAA testing is currently done using objective items (Bull, 1999) the following words were also included: 'multiple-choice', 'MRQ' 'objective test(s)', 'objective item(s)', 'objective testing', 'item bank(s)'. The implementation and evaluation of large-scale CAA systems is also at issue so the phrases 'implementation of Learning Technology (LT)' and 'evaluation of Learning Technology' were incorporated.

It became apparent that the review would be a substantial undertaking from the number of articles and references found during the literature search. The following print journals were searched: *Assessment & Evaluation in Higher Education* (19 articles found that are relevant, *British Journal of Educational Technology* (BJET) (13 relevant articles found, most of which were found in a special issue on CAA & online assessment [Vol. 33 No. 5, November 2002]), *Computers in Education(* three relevant articles found), *Computers in Human Behavior* (one article of moderate relevance found) and *Journal of the Association of Learning Technology* (ALT-J) where seven directly relevant articles were found.

Online journals searched included *Australian Journal of Educational Technology* (AJET): 90 matches found of which three were relevant and *The Journal of Technology, Learning and Assessment* (JTLA) [www.jtla.org] (two relevant articles). The following citation indices were searched: *British Education Index* (BEI), *Current Index to Journals in Education*, ERIC (13 matches found, of which eight were relevant), Education Index, Educational Technology Abstracts and Social Sciences Citation Index. The following Conference proceedings were searched: the third (1999) through to the eighth (2003) International CAA Conference proceedings [www.caaconference.com] - 146 articles found, all of which were, as could be expected, directly relevant.

Theses collections searched included *Dissertation Abstracts* which stores mainly American theses; ten matches were found, but none were particularly relevant and the Index to Theses Online [www.theses.com] where British doctoral theses are kept; two matches were found but abstracts did not indicate much relevance to the research. The following UK Web sites were searched, including so-called 'grey' resources: the *British Educational Research Association's* (BERA) website [www.bera.ac.uk] - 34 matches were found of which one was relevant, the *Bath Information and Data Services* (BIDS) site [www.bids.ac.uk] - 41 matches found of which 21 were relevant), the *CAA Conference* site at Loughborough University [www.caacentre.com] - three relevant articles found, the UK Government *Department for Education and Skills* (DFES) site [www.dfes.gov.uk] - 20 matches found, none of which were particularly relevant, the *Joint Information Services Committee* (JISC) site [www.jisc.ac.uk] - more than 300 matches found, of which 12 were found to be relevant, the *Learning and Teaching Subject Network* (LTSN) website [www.ltsn.ac.uk] - six matches found, two relevant, the *Scottish Centre for Research into On-Line Learning and Assessment* (SCROLLA) site [www.scrolla.ac.uk] - 158 matches found of which three were directly relevant, the *Scottish Computer Assisted Assessment Network* (SCAAN) [www.scaan.ac.uk] - two matches found of which one was directly relevant and the *Social Science Information Gateway* (SOSIG) [www.sosig.ac.uk] - 68 matches found, of which two were directly relevant. Offshore web sites searched included the *American Educational Research Association* (AERA) [www.aera.net] - no matches found, the *Australasian Society for Computers in Learning in Tertiary Education* (ASCILITE) site [www.ascilite.org.au] - seven matches found, of which four were relevant and the *Teaching, Learning and Technology Group* (TLTG) [www.tltgroup.org] - none found relevant. It soon became clear that most of the published material on CAA was in the form of articles from learning technology (LT) journals and the proceedings of specialist conferences.

This section described the method used to compile the literature review, which as a GT review differed from a traditional review by covering the general area of interest rather than a narrowly defined field. The scope of the search included CAA specific literature and other literatures relevant to a GT study of CAA uptake. The search was conducted in standard citation indices, learning technology journals and standard works of reference.

2.3 Categorising assessment

Assessment can be categorised according to importance, timing and the learning outcomes being assessed. Six kinds of cognitive objective are distinguishable according to Bloom's (1956) classic taxonomy of the cognitive domain: simple recall of knowledge is at the most fundamental level, rising through comprehension, application, analysis, synthesis and ultimately to evaluation at the highest levels. Others have extended it (Anderson, Krathwohl and Bloom, 2001; Krathwohl, Bloom and Masia, 1964) or adapted it, as in Imrie's (1995) RECAP model. Alternative taxonomies have been proposed which remain little used in CAA, for example Steinaker and Bell's (1979) experiential taxonomy which provides a holistic framework covering cognitive, psychomotor and affective domains. Although tutors in higher education assess the full range of outcomes (Miller, Imrie and Cox, 1998 p. 56), it is the view of many that higher education should specialise in developing the highest level skills, particularly evaluative ('critical') skills (Barnett, 1997).

Cognitive learning outcomes at the lower end of Bloom's taxonomy are traditionally assessed on a convergent basis - there is only one 'correct' answer - whilst higher order outcomes are most readily assessed on a divergent basis, where a range of informed responses and analyses is permissible (McAlpine, 2002b). Convergent tests are readily constructed using objective items, but divergent testing relied traditionally on the long written answer (essays), the automated marking of which presents real challenges (Mason and Grove-Stephensen, 2002).

2.3.1 ASSESSMENT EVENTS

Assessment events can be broadly categorised as either summative - administered by tutors at the end of a teaching unit for grading purposes - or formative, which is designed to give immediate feedback and is designed to assist the learning process. Diagnostic assessment is used by tutors to determine students' prior knowledge and self-assessment is where students assess their own understanding (Bull and McKenna, 2004; O'Reilly and Morgan, 1999). Other categorisations include Formal/Informal - delivered under invigilated conditions, or not and Final/Continuous - delivered only at the end of a course, or distributed throughout. Sclater and Howie distinguish six different applications of CAA under three main headings as follows:

<u>'Credit bearing' or high-stakes summative tests</u> that may be *either* formal examinations *or* continuous assessment, <u>Formative self assessment</u> that can be *either* 'authenticated' self-assessment *or* anonymous self-assessment, <u>*Diagnostic* tests</u> that evaluate the student's knowledge *either* by pre-testing before the course is commenced *or* by post-testing to assess the effectiveness of the teaching (Sclater and Howie, 2003 pp. 285-286).

Assessments may be 'high stakes', 'low stakes', or somewhere in between and much of the pressure on academic and support staff who are running CAA tests derives from the influence that the outcome has on participants' futures (Boyle, Hutchison, O'Hare and Patterson, 2002 p. 272). High stakes assessments are the most sensitive applications of CAA. Shepherd's (2001) summarised the properties of low, medium and high stakes assessments (Table 2):

Property of test	Low	Medium	High
Decisions	None	Can be reversed	Difficult to reverse
ID individual	None	Important	Very important
Proctoring	None	Yes	Constant
Options	Study more	Pass, fail, work harder	Pass or fail
Item & test development	Minor	Takes time	Significant
Items created by	Subject expert	Subject expert	Subject expert
Statistics checked	Subject expert	Time to time	Psychometrician

Table 2: Shepherd's (2001) interpretation of summative assessment stakes

2.3.2 DEFINING CAA

Bull and McKenna's definition of CAA as 'the use of computers for assessing student learning' (Bull and McKenna, 2004) is an inclusive one that refers also to specific applications of technology in assessment. Where terms include other terms in this way, it can be useful to show their relationships as a Venn diagram (Figure 3). **Computer-based assessment** (CBA) is a computer program marking answers entered directly into a computer system, **optical mark reading** (OMR) assessments use computers to mark scripts that were originally composed on paper and **portfolio collection** is the use of computers to collect scripts and written work of all kinds. CBA can be subdivided into standalone applications that only require a single computer (such as the earliest versions of Question Mark™), networked applications that work on private networks and those designed to be delivered across public networks such as the world-wide web - online assessment (Figure 3).

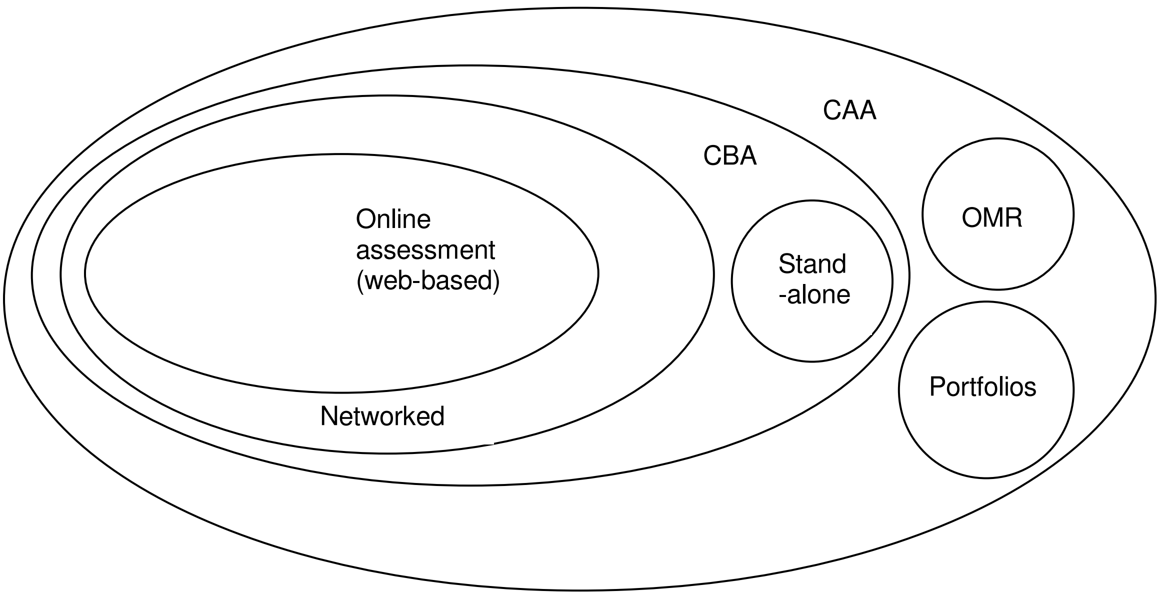

Figure 3- Different types of CAA

CAA systems vary widely in terms of cost, flexibility and scalability. For instance, the JISC funded Tools for Inoperable Assessment (TOIA) package is currently free of charge to UK FE and higher education (TOIA, 2004) whilst the TRIADS tools (McKenzie, Hallam, Baggott and Potts, 2002) were (until recently) free. Other tools are available on a commercial basis and represent considerable investments with proprietary systems such as QuestionMark

Perception™ at the upper end of both cost and functionality scales (Questionmark, 2004). CAA systems vary widely in terms of the number of question types they support and in the control administrators have in scheduling assessments; for example Perception 3 supports 18 objective item types, whereas the TOIA tools support five item types and the current release (6.1) of the Blackboard Learning System in use at Southampton supports six.

More costly CAA systems are sold on scalability and flexibility with full-time software support; however scalability across large institutions appears to be a perennial and largely unresolved issue (Cosemans, Van Rentergem, Verburgh and Wils, 2002; Danson, Dawson and Baseley, 2001). CAA systems differ in capacity (the number of assessments that can be taken simultaneously) and in the mechanisms that support this such as the capability to authenticate participants via single LDAP sign-on (Questionmark, 2004).

2.4 CAA uptake

The Association for Learning Technology (ALT) recently identified six ways that the strategic application of a learning technology such as CAA may add value to the efficiency and effectiveness of the learning process and six other factors that may influence adversely the value it can add (ALT, 2003 p. 6). These issues are conspicuous in much of the research on implementing CAA strategically. Learning technologies may be grouped according to maturity - whether or not they have reached majority use across the sector - and by whether they foster collaboration (Figure 4).

Some types of learning technology	Estimated time taken for LT to reach majority use in HE ➔						
	1980	1985	1990	1995	2000	2005	2010
'One-way' learning technologies		Web pages➔					
				CAA ➔			
Collaborative learning technologies	Email➔						
			VLEs ➔				
					MLEs ➔		
				Tele-presence ➔			
					Mobile technology ➔		

Figure 4- Some learning technologies arranged by type and (estimated) maturity

CAA has obvious similarities with other LTs such as VLEs and MLEs in terms of widespread agreement about the difficulty of implementing it on an institutional scale (Sommerlad, Pettigrew, Ramsden and Stern, 1999), the level of it's technical maturity and in terms of majority use across the sector. CAA differs from other LTs in that the stakes are much higher, particularly where it is used for examinations (QAA, 1998).

Students are increasingly litigious (THES, 20004e; 2004f) and the clear scoring schemes of objective tests open the results of CAA tests to scrutiny, rendering deficits in practice apparent in ways to which more traditional forms of assessment are less susceptible. This makes risk management particularly important (Zakrzewski and Steven, 2000).

Apart from the contribution of existing research on the uptake of learning technologies generally, the literature concerned with the nature of CAA uptake was found to comprise four other distinct areas, two of which were CAA specific namely known obstacles and drivers (which Hambrick (2002) refers to as 'critical factors') and current CAA activities. Diffusion scholarship and organisational change drew on other fields of research.

2.5 Known factors governing CAA uptake

Human endeavour is subject to obstacles that impede progress and enabling factors that promote it. Assessment activities are no exception and after several thousand years of experience, the critical factors influencing traditional verbal (*viva voce*) and paper-based assessment should by now be well understood. Even so, not all traditional assessments run smoothly (e.g. THES, 2002b). Many of the obstacles and drivers that influence traditional assessment such as perceived risks of administrative mistakes in assigning grades to wrong candidates, or candidates obtaining sight of examination questions before the test, are carried across to CAA. Indeed, the emergence of CAA as a new specialist field of practice appears to have forced the re-examination of dormant issues in traditional practice. One argument for establishing good CAA practice at an institutional level is that it triggers the re-examination of assessment practice generally (Bull and McKenna, 2004).

2.5.1 LIMITATIONS OF TRADITIONAL OBJECTIVE ITEM TYPES

In contrast to marking essays, marking objective test scripts is in principle a simple repetitive task. Current activities in computer-based assessment (CBA) represent the latest attempts to automate the assessment process, where issues such as the suitability of objective items for testing higher education skills are being encountered again with CAA (Bull and McKenna, 2004; Pritchett, 1999). Contemporary activities in CAA and computer-assisted learning (CAL) rehearse pedagogic issues first encountered in Skinner's use of teaching machines for programmed instruction in the last century (Anglin, 1995; Saettler, 1968). Most CAA activity is still based on objective testing (Bull, 2001; Bull, 1999; Bull et al., 2002; Bull and McKenna, 2004), which began as a paper-based activity and is long established in the US and elsewhere for standardised testing in schools, college entrance and psychological testing.

The limitations of existing objective item types and of their implementation in CAA item design together with the development of new automated item types provide fertile ground for discussion. A major concern related to the nature of objective tests is whether multiple choice questions (MCQs) are really suitable for assessing higher-order learning outcomes (HLOs) in higher education students (Davies, 2002) and this is reflected by academics and QA staff (Bull, 1999). The most optimistic view is that item-based testing is appropriate for examining the full range of learning outcomes in undergraduates and postgraduates, provided sufficient care is taken in their construction (Duke-Williams and King, 2001; Farthing and McPhee, 1999). MCQs and multiple response questions (MRQ) are the two most frequently used types (Boyle et al., 2002) with pressure for the use of more sophisticated question types (e.g. Davies, 2001).

2.5.2 ISSUES OF VALIDITY AND FAIRNESS

Concerns regarding the risk of test-takers achieving passing scores in objective tests by guessing are addressed in two main ways in the literature: by discounting a test's guess factor and by adjusting the marking scheme away from simple tariffs where 'one correct answer equals one mark' to include the possibility of negative marking where incorrect responses are awarded negative scores. Confidence-based assessment means marks are awarded according to participants' confidence that the correct response has been given (Davies, 2002; Gardner-Medwin and Gahan, 2003; McAlpine and Hesketh, 2003).

Cheating in summative tests is addressed in the literature by the use of 'blinker screens' and proper invigilation, by interleaving the participants of one test with another and by randomising item order and response order (BSI, 2002; Bull and McKenna, 2004; Pain and LeHeron, 2003). Other tactics include creating large banks of items. Individual question items include all the components for delivering a single objective question and tests are collections of items that may be chosen from subject-specific collections of items which are commonly known as 'item banks' (Figure 5). Sclater positioned item banks as a crucial driver of CAA (Herd and Clark, 2003 p. 2) whilst McAlpine argues in one of the CAA Centre 'bluepapers' for the routine adoption of item banks based upon the vulnerability of CAA tests to challenges from students on the grounds of fairness, validity, security or quality assurance (McAlpine, 2002a p. 4).

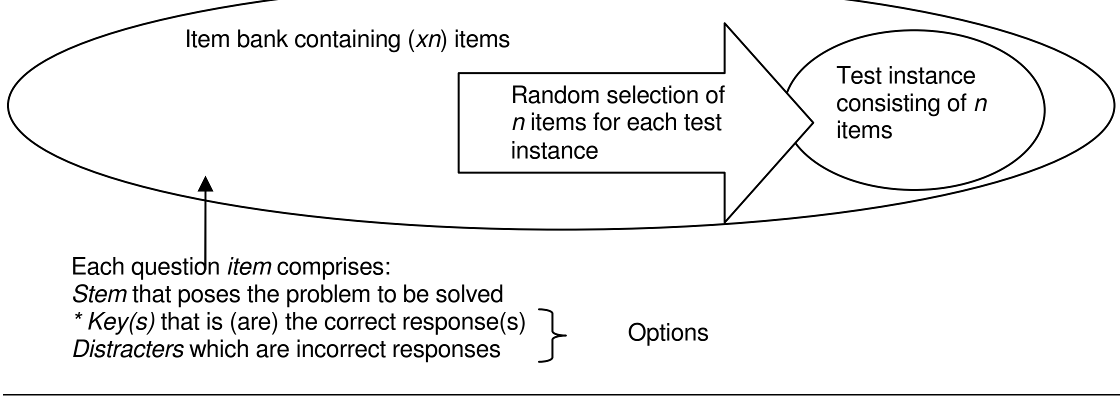

Figure 5- Test selection from an item bank

The CAA Centre produced a set of specialist publications on CAA, including the 'Blueprint for CAA' (Bull and McKenna, 2002) and two other 'bluepapers' outlining the basic principles of assessment (McAlpine, 2002b) and (objective) item analysis which covers the elements of Classical Test Theory (CTT), the three basic models in Item Response Theory (IRT) and a brief description of Rasch measurement (McAlpine, 2002c). Boyle et al. (2002) describe all three modes of analysis - Classical Test Theory , Item Response Theory and Rasch analysis - with a set of 25 questions used with 350 test-takers. They argue that the present approach of many CAA practitioners to neglect rigorous quality assurance (QA) of items is untenable and this is especially so for medium and high stakes use. Boyle and O'Hare insist that training in item construction and analysis should be obligatory for staff who are involved in developing CAA tests and that items must be peer-reviewed and trialled before use (Boyle et al., 2002 p. 77).

2.5.3 PREVIOUS INITIATIVES TO IDENTIFY CRITICAL FACTORS

Approaches to identifying and classifying the critical factors in applying technology to assessment are typically survey based, although one case of a Delphi study was found (Hambrick, 2002). Stephens and Mascia conducted the first UK survey of CAA use in 1995 using a 10-item questionnaire which attracted 445 responses from academics. The key cultural factors they identified were institutional support in terms of training and resourcing, allowing time for academics to develop CAA tests, making CAA a fully integrated part of existing assessment procedures (rather than an afterthought) and subject-related dependencies. Other factors were student familiarisation with the tools, well-planned procedures that address security and reliability issues and cooperative IT departments (Stephens and Mascia, 1997 pp. 26-27).

Four years later the CAA Centre, a phase 3 Teaching and Learning Technology Project (TLTP3) funded initiative, conducted a national survey of higher education that focussed on use and attitudes. Aims included identifying obstacles and drivers, pedagogical benefits and limitations, the current nature of CAA assessments, the kind of support available and what policies governed the use of CAA. The survey built on Stephens and Mascia's (Bull, 1999) but the instrument was more detailed with more than twice as many items, many of which were multi-part (Bull, McKenna and Hesketh, 1999). It was delivered in variants tailored to the differing perspectives of tutors, educational technologists, staff developers and QA staff. It attracted more than 750 responses overall, of which nearly 80% were from academics. The rest were from educational technologists (11%), quality assurance (QA) staff (3%) and staff developers (9%) which was said to represent around a 10% responses rate (Bull, 1999).

Institutional factors identified by academics in 1999 appeared to be a superset of 1995 findings. The greatest institutional obstacle to the uptake of CAA was seen to be cost both in terms of personal time invested and the expense of commercial 'shrink-wrapped' CAA software (Bull, 1999 p. 6). Unrealistic expectations stemmed from naïve appreciations of the underlying theory and practice of CAA which was coupled with inherent conservatism and lack of technical and pedagogic support. The greatest obstacle to CAA uptake by individual academics was perceived to be lack of time exacerbated by the perceived steep learning curve associated with getting to grips with the technology and constructing specialized CAA question types, including the difficulty of constructing objective items that reliably assess higher-order learning outcomes (HLOs) which resonates with the (2003) findings of Boyle and O'Hare. A perceived credibility gap existed between what CAA advocates promised and what respondents thought could reasonably be delivered; lack of support, resistance to change and technophobia were cited less often. Issues of unfriendly software, academics working in isolation and individual inertia were raised. Subject-specific shared question banks (Herd and Clark, 2003 p. 21) and exemplars were important drivers for the large-scale uptake of CAA, but CAA 'evangelists' and adherence to institutional guidelines was less crucial.

At an individual level, academic commitment and overcoming initial user obstacles were important drivers for CAA uptake. Faculty support for CAA was limited (mainly restricted to occasional time release) and it seemed that external funding was the principle way of supporting CAA at that level. Another important factor was the need to embed CAA within normal teaching. Most CAAs were web-based, although a large fraction of respondents delivered CAA using closed networks and a small percentage used OMR. Only a third were invigilated and most of the summative CAA tests restricted the percentage weighting to a third or less, although in a very small number of cases CAA supplied 100% of all marks awarded for a module. CAA was used to test a range of group sizes up to very large (more than 200) numbers of students. Subject-specific differences in the uptake of CAA centred on the increased likelihood of its use where undergraduate knowledge is less contested such as mathematics and the sciences (Bull, 1999). Interestingly, QA staff identified few enabling factors, perhaps indicating a largely negative perception of CAA (Bull, 1999; Bull and Hesketh, 2001; Bull and McKenna, 2000).

2.6 Current activities and debates

2.6.1 COMPUTER-ADAPTIVE TESTING

Concerns about workstation availability and whether objective items explore the limits of a participant's ability were addressed to some degree by computer-adaptive testing (CAT) which involves issuing questions at a difficulty level depending on the test-taker's previous responses.

When questions are answered correctly, the estimate of ability is raised and a more difficult question is presented and *vice versa*, giving the potential to test a wide range of student ability very concisely. For example, Lilley and Barker (2003) constructed a database of 119 peer-reviewed items (the minimum being 100) and gave both 'traditional (non-adaptive) and CAT versions to 133 students on a programming course from the same item bank. Their approach to the adaptive element of assessment was based on the three parameter Item Response Theory model where the probability of a student answering an item correctly is given by an expression that takes account of its difficulty, discrimination and guess factor. Students' results from the CAT version of the test correlated well with their results from the traditional version and that they didn't find the CAT test less fair (2003 p. 177). Because CAT items are written specifically to test particular levels of ability rather than all, it has the potential to deliver results that are more accurate and reliable that traditional CAA tests.

2.6.2 COMPETENCE-BASED ASSESSMENT AND SIMULATIONS

The focus of much of the CAA literature is clearly on the migration of existing assessment tasks from paper to screen, and this is understandable bearing in mind the current emphasis on assessing learning outcomes Bloom's cognitive domain. However, the abstraction of assessment activities for skills in the psycho-motor domain has been blamed for raising a generation of engineers who 'know that' rather than 'know how' (Daily Mail, 2004). Computers can be used to assess performance in more or less sophisticated simulations of tasks which require complex psycho-motor skills (see, for example, Bennett, 2002a) and some examination boards have recently begun to use such tools in public examinations (Maughan and Mackenzie, 2004; Thomas, Ashton , Austin, Beezers, Edwards and Milligan, 2005). The ability to assess skills of these kinds appears to be a significant advantage of screen-based assessment methods.

2.6.3 INTEROPERABILITY

A current live issue is interoperability between CAA systems and VLEs. Lay and Sclater (2001 p. 1) identify two reasons why the interoperability of question items and tests may be important in embedding CAA: whether the question banks being created today be accessible in future years when the current CAA systems are no longer in use and can student assessment data be transferred from the CAA system to the institutional student records system. This is particularly important when preserving the investment made by users of older and newer systems. The IMS Consortium's Question and Test Interoperability (QTI) specification (IMS, 2003) is arguably the leading candidate for an 'open' CAA lingua franca (Lay and Sclater, 2001) but is seen as a starting point and to require considerable further development (Sclater and Howie, 2003; Sclater, Low and Barr, 2002). Proprietary standards such as Questionmark Markup Language (QML) exist but usually tie users in to particular products.

2.6.4 COMPLIANCE WITH PUBLISHED STANDARDS

The recent Code of Practice for the use of information technology (IT) in the delivery of assessments - better known as BS7988:2002 - acknowledges that increased use of CAA 'has raised issues about the security and fairness of IT-delivered assessments, as well as resulting in a wide range of different practices' (BSI, 2002 p. ii). BS7988 aims to enhance the status of CAA and encourage its wider use in appropriate applications by demonstrating its fairness, security, authenticity and validity. However, the *Code of Practice*'s focus on the delivery of CAA tests could lead to the relative neglect of earlier stages in the preparation and quality assurance of assessments: 'A poor assessment, delivered appropriately, would conform to BS7988' (Boyle and O'Hare, 2003 p. 77)

Boyle and O'Hare identify three other prescriptions: the American Educational Research Association (AERA) *Standards for Educational and Psychological Testing*, the Association of Test Publishers (ATP) *Guidelines for Computer-based Testing* and the Scottish Qualifications Authority (SQA) *Guidelines for Online Assessment in Further Education* as guides to good CAA practice in that they encourage a more all-round treatment of the entire production process including the selection of appropriate question types and analysis of item quality (p. 77). It was noted in chapter 1 that Dearing set a target of 1999/2000 for all higher education institutions to have strategies for the adoption of learning technologies. It was noted that no references were found linking strategy documents with general codes of practice such as those discussed here.

2.7 Diffusion of innovations

The study of the ways in which innovations such as CAA are taken up is sometimes referred to 'diffusion scholarship' or just 'diffusion'. The standard reference on the diffusion of innovations is probably Rogers' *Diffusion of Innovations* (2003) where the origins of diffusion literature are traced to European roots beginning with Tarde's systematic observations of social trends.

2.7.1 ORIGINS OF DIFFUSION LITERATURE

Tarde's 'laws of imitation' (imitation is equivalent in meaning to 'diffusion') were a set of generalisations used as a tool to:

> learn why, given one hundred different innovations conceived at the same time—innovations in the form of words, in mythological ideas, in industrial processes, etc—ten will spread abroad while ninety will be forgotten. (Tarde, 1962 p. 140)

Tarde was a statistician who discovered the s-shaped curve that is still assumed to characterise the uptake of innovations (usually now shown as a bell-shaped curve) and identified the upswing of the curve as the point at which opinion leaders start using the innovation (1962 pp. 122-127).

Simmel prescribed ‘social strangeness’ in the 1920’s as a tool for obtaining insights into social structures from which developed modern notions of professional naivety. The German-Austrian and British ‘diffusionists’ were the first to use the word ‘diffusion’ in the 1930’s and are named after it. Rogers assesses the importance of their contribution as crucial in drawing the interest of contemporary sociologists to the phenomenon and tracks Ryan and Gross’ seminal study back to it. He notes that the American literature on the diffusion of innovations originated, for practical purposes, in the mid-twentieth century with Ryan and Gross’ empirical study of the diffusion of hybrid seed corn amongst Iowa farmers in the 1940’s (2003 pp. xv-xvi). Rogers’ field was the post-war diffusion of agricultural innovations where much of the earlier literature on diffusion was also grounded (2003 p. 47).

2.7.2 ELEMENTS OF DIFFUSION STUDIES

According to Rogers, an innovation is ‘an idea, practice, or object that is perceived as new by an individual or other unit of adoption’ (2003 p. 12). He identifies five distinct phases in which innovations are taken up, each of which can be characterised according to the attributes of users involved in each (Figure 6). Rogers accepts Tarde’s assumptions that diffusion follows a ‘bell-shaped’ distribution and that the boundaries of different segments can be determined according to statistical significance. He refers to the small segment whose members adopt innovation less than two standard deviations (s.d. or ‘σ’) from the mean time as ‘innovators’: similarly those whose adoption time is between one and two standard deviations less than the mean time are ‘early adopters’. The ‘early majority’ occupies a position less than one standard deviation from the mean time and the ‘late majority’ has the equivalent position within one standard deviation more than the mean time. ‘Laggards’ take more than one standard deviation longer than the mean time to adopt an innovation.

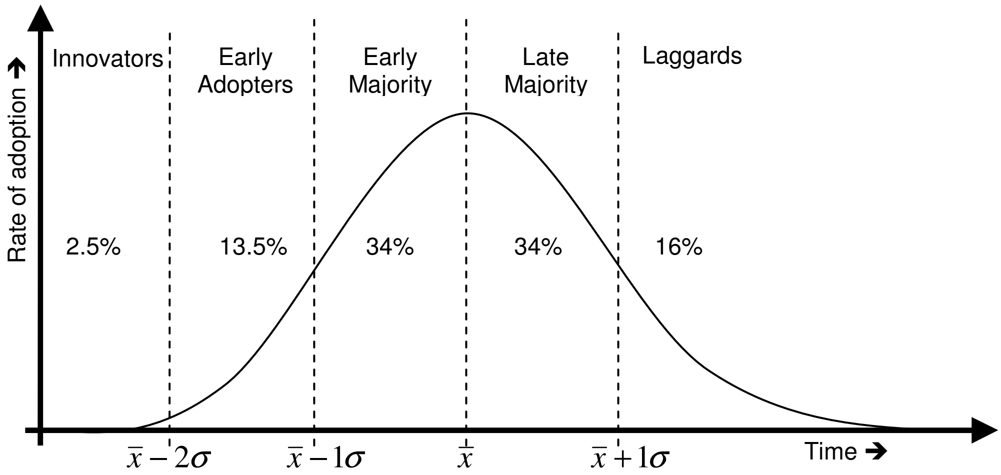

Figure 6- Rogers' technology uptake curve

Innovators are characterised as 'venturesome'. They 'have interpersonal networks [which] extend over a wide area' and are said to be 'able to cope with higher levels of uncertainty about an innovation than are other adopter categories' (2003 p.22) They are the first to adopt the innovation and are described as having 'a desire for the rash, the daring and the risky' (2003 p.283). These characteristics do not necessarily earn the respect of their peers, but they have a vital gatekeeping role in uptake of new ideas. Early adopters differ from innovators in that they enjoy the respect of their peers and have the highest degree of opinion leadership. Potential adopters look to early adopters for advice and information. Their role is vital in triggering a 'critical mass when they adopt an innovation' (2003 p.283).

The early majority is 'deliberate' and more risk averse than innovators. They 'seldom hold positions of opinion leadership' and 'may deliberate for some time before completely adopting a new idea… they follow with deliberate willingness in adopting innovations but seldom lead'. (2003 pp.283-4). In contrast the late majority is 'sceptical' and more risk averse, being inclined to wait until most people they know have adopted the innovation. With the early majority they make up two thirds of the possible adopters of an innovation.

Laggards are 'traditionalists' and occupy the final 16% or so of the population which is classically more than one standard deviation longer than the average time to adopt an innovation. They are 'suspicious of innovations and of change agents' although this is 'entirely rational from the laggards' viewpoint, as their resources are limited…' (2003 p.284). Resource limitations in higher education include tutors' time in addition to financial limitations.

Diffusion scholarship is widely cited in the US literature as a framework for positioning the uptake of learning technologies (see Anglin, 1995; Carr, 1999; Geoghegan, 1994; Simonson, 2004; Surry and Farquhar, 1997 for reviews of US applications of diffusion scholarship to educational technology uptake). It was until recently less widely cited in the UK literature but is now generally accepted as the dynamic context of learning technology uptake (see, for example, Bacsich, 2005a; Bacsich, 2005b; see, for example, Hanson, 2004). Although it focuses on the diffusion of healthcare innovations, the NHS National Co-ordinating Centre Service Delivery and Organisation's (2004) report 'How to spread good ideas' is a comprehensive UK academic review of the diffusion literature which illustrates the scope of diffusion scholarship's contribution to the understanding of technological innovation in the UK.

2.8 Lewin and organisational change

Some mechanisms that underpin diffusion are exposed in the scholarship of organisational change. Kurt Lewin's interest in the behaviour of groups led to his discovery of Field Theory and Group Dynamics which facilitated social group analysis, whilst his interest in fostering social change led to the discovery of Action Research and the 3-Step 'freeze' model of change facilitated changes (Burnes, 2004). Field Theory and the 'freeze' model are particularly relevant to the diffusion of innovations such as CAA, a brief account of which follows.

Lewin's (1944) Force Field model divides factors into 'driving' and 'restraining' forces. Some are more influential than others, so are shown as differing in strength. If the sum of driving forces is in equilibrium with the sum of restraining forces, change is unlikely to occur (Figure 7).

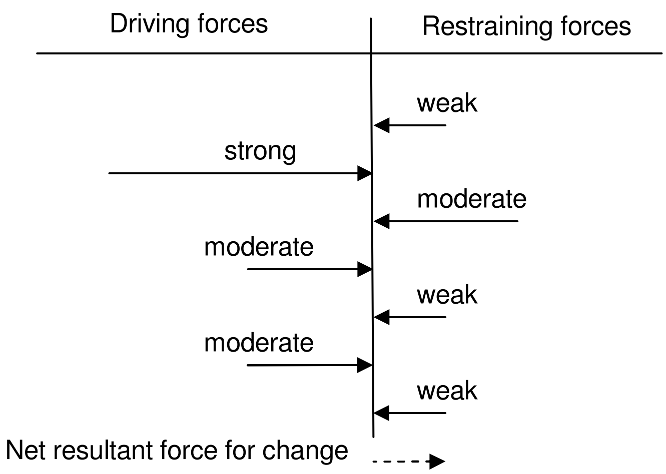

Figure 7- Lewin's Field Theory model of change (derived from Lewin, 1944 p. 240)

If however there is a net weakening of the restraining forces, or a net strengthening of driving forces - or indeed, both of these - then the equilibrium will be disturbed and a shift towards the 'target' state will be more likely. In this study, forces driving change will be referred to simply as 'drivers' and restraining forces that oppose change will be referred to as 'obstacles'.

Lewin noted that organisations have an in-built tendency to become 'frozen' into change-resistant stable configurations. If this 'is not addressed the organisation will retain a revisionist tendency that often results in a return to the previous equilibrium (Lewin, 1944, 1947, 1958).

Lewin described a three-stage representation of change which became known as the 'Freeze' model which entails the recognition that the target organisation is frozen into a configuration which will, if left to itself, not only resist change but will when disturbed tend to snap back into its original shape. This is a resolved by 'melting' the organisation so that it becomes susceptible to being cast into a new shape under the influence of the forces driving change. Once the desired configuration has been attained, the organisation is 'refrozen' so that it once more becomes resistant to change, including the tendency to return to its previous form. Lewin himself insisted that this three-stage sequence does not mean that groups can simply be frozen finally into a desired configuration once this is reached but rather that social groups exist in a state of continual adaptation:

> 'Change and constancy are relative concepts; group life is never without change, merely differences in the amount and type of change exist' (Lewin, 1947 p. 199)

One obvious implication of the 'freeze' model for this research is that current pressures for change in universities may be great enough to overcome organisational inertia and make possible changes in assessment practice that accommodate CAA. The question then is whether tutors continue using CAA once they've started - or whether they slip back to original practices once the immediate pressure for change abates.

2.9 Chapter summary

This chapter comprised the second part of the background theory section including the method used to compile the review and an account of different kinds of CAA activities. This was followed by a description of known critical factors acting as obstacles or drivers, which led to a discussion of how classical diffusion theory and Lewin's ideas about organisational change might influence the uptake of CAA. The findings of this review informed both the methodology which is described in the focal theory section (chapter 3) and the early stages of the GT analysis described in the data theory section (chapters 4 through 6).

Literature reviews in theses often end with a statement of where gaps exist in the literature and how the research may be conducted to address these (Phillips and Pugh, 1994). As described in section 2.2, a grounded theory approach was taken in this study and consequently this review does not set out to identify gaps in the literature. Rather it served to sensitise the researcher and to provide some initial concepts as a starting point: research questions are refined during successive iterations of data gathering and analysis (Strauss and Corbin, 1998a).

3 Methodology

In this chapter the research questions are used to develop a methodological design for the study. The philosophical foundations of the methodology are described and the validity of the design is grounded in generally accepted practice. The landscape of educational research, particularly those areas relevant to this study, is outlined. The overarching research paradigm is described and some alternative techniques considered as possible methodologies. The methods used to collect and analyse data are described. Links are made to the data collection and analysis procedures in the following chapters.

3.1 Research questions

In this section I describe how the research questions informed the overarching design of the study. The next section aims to establish the validity of the design by demonstrating its derivation from basic and widely-accepted principles of theory generation.

3.1.1 TYPES OF QUALITATIVE RESEARCH QUESTION

Educational research literature suggests a broad range of ways to apply qualitative research techniques to education research problems, although issues of how to frame initial research questions are generally left to the wider literature on qualitative research. For example, Cohen and Manion's widely cited handbook for educational researchers *Research Methods in Education* deals (as the title implies) principally with the application of standard qualitative methods, such as interviews and case studies, to educational research problems (Cohen and Manion, 1994). However, the general qualitative research literature is well stocked with suggestions for the kinds of question that can be addressed appropriately with qualitative research, many of which are richly cross-referenced with the suggestions of other writers in the field. Two widely-cited volumes are Denzin and Lincoln's (2000) extensive *Handbook of Qualitative Research* (a sourcebook spanning the qualitative landscape in paradigmatic and methodological dimensions) and Miles and Huberman's *Expanded Sourcebook of Qualitative Data Analysis* (Miles and Huberman, 1994)

In the *Handbook*, Janesick's chapter employs choreography as a metaphor for undertaking qualitative research projects (2000 pp. 382-384). She describes the process of asking research questions as 'warming up and preparation': deciding what primary research questions to ask is a basic design decision which prepares the ground for the main body of the work-

> …I always start any given research project with a question… [which] informed all my observations and interviews and led me to use focus groups and oral history techniques later in the study (p. 383).

She contrasts the case-based interests of the qualitative researcher with the 'bulk' approach of quantitative investigator and lists ten example of qualitative research questions including some pertaining to the forces working in social systems such as schools or other organisations (2000 p. 382). The initial design may be based on research questions that provide a central structure for the study and which influences later design decisions made during the course of the study:

> If one thinks of the design of the study as the spine and the base of the spine as the beginning of the warm-up in dance, one can see that the beginning decisions in a study are very much like the warm-up for the dance and the predesign decisions made by the choreographer. (p. 383)

Miles and Huberman refer to Smith's multi-dimensional continuum of qualitative research questions that vary in the extent to which causal links are being investigated and the ends to which findings will be put - basic research, policy formation, evaluation or management (Smith (1987) cited in Miles and Huberman, 1994 p. 24). The form of research questions defines what approaches are appropriate which has consequences for the validity of the results. Care was taken to ensure that the research questions asked at the outset were answerable using existing methods and likely to generate usable results.

3.1.2 MATCHING THE RESEARCH DESIGN TO THE RESEARCH QUESTIONS

The research questions posed in chapter 1 began with 'why is CAA uptake not higher than it is' and a related (secondary) research question was 'what could be done to secure the benefits of CAA where appropriate'. These questions led to the framing of a research problem which was to obtain a good understanding of the mechanisms underlying CAA uptake in UK universities. The need to understand the common features of good practice in the sector was basic to this and prompted two sub-questions. These were framed as 'what do good CAA applications look like?' and having recognised them, 'What practice underlies good CAA applications?'

The first of these sub-questions is to recognise 'how is something done well?' which Miles and Huberman classify as a 'non-causal management' type. The second is to understand 'what makes something good?' which they classify as 'non-causal evaluation' (1994 p. 24).

When considering the first sub-question of how to recognise good ways to implement CAA applications in UK higher education, four secondary sub-questions were suggested. The first of these (1.a) was 'how are computers used?' For example, not all applications of CAA were computer-based; in some applications computers are used indirectly for assessment purposes and not for marking, as in peer assessment or portfolio applications. Conversely, in other cases such as optical mark recognition (OMR) computers are used to mark assessments but not to present them. The second came from the observation that CAA applications differed in the type of network used to connect participants' workstations with CAA servers. For example, closed networks were used in some implementations to reduce the risk of infrastructure problems causing loss of student during exams, whereas in others assessments were delivered using institutional intranets or even the internet? This was framed as (1.b) what network implementations work best with CAA? The third question came from the observation that the preliminary literature review revealed no consensus about what metrics existed to assess CAA uptake and how CAA applications could be compared. This was framed as (1.c) what metrics could be used to assess the performance of CAA systems in higher education? The fourth question stemmed from an assumption that suitable metrics could be agreed, so that applications could be compared and common features of good practice identified. This was framed as (1.d) what underlying features good CAA systems share.

The second sub-question of what characterises good CAA practice in higher education in turn prompted two sub-questions. Firstly, I supposed the quality of higher education CAA practice to be related to critical factors influencing CAA assessment generally. The question was framed as (2.a) what are the principal obstacles to & drivers of CAA in higher education? Secondly, I expected good CAA practice to be related to the perceived benefits and drawbacks of different kinds of higher education assessment practice generally. This question was framed as (2.b) what are the benefits and drawbacks of using CAA in higher education? I expected the research design to be driven by these sub-questions and thereby provide answers to the research questions (Figure 8).

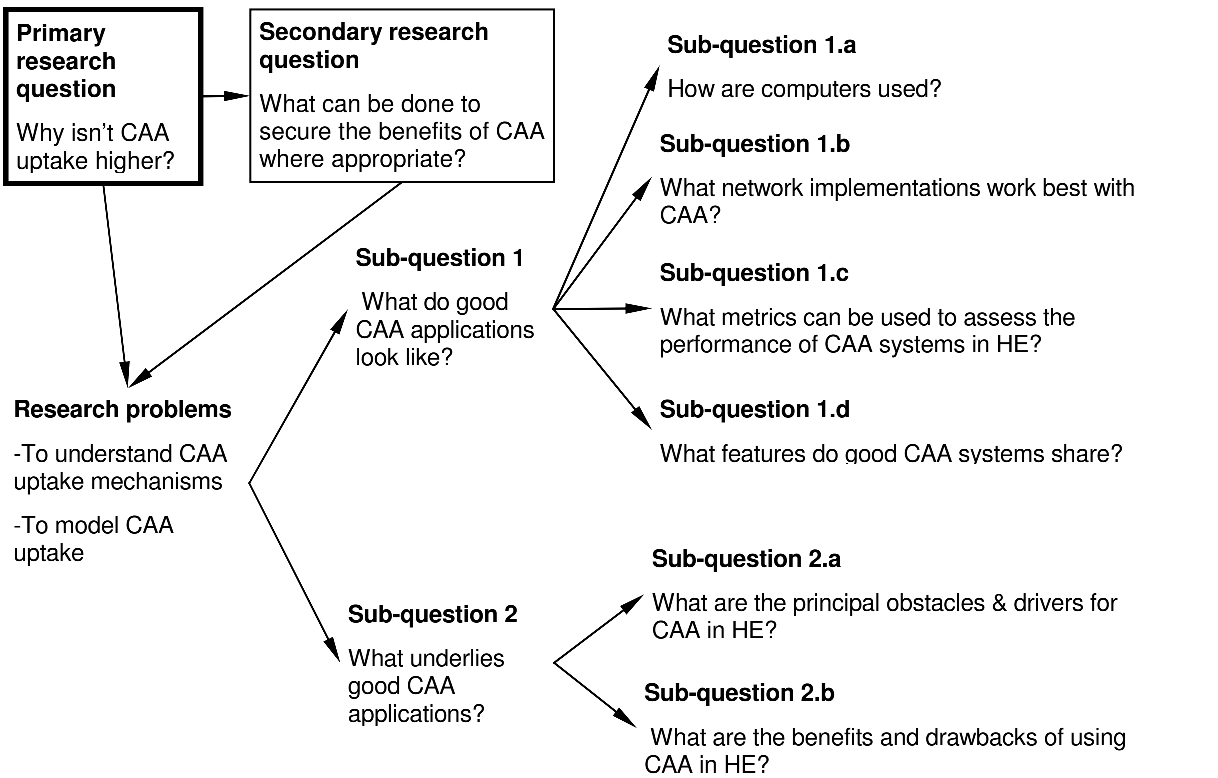

Figure 8- Links between research questions, research problem and sub questions

3.2 Philosophical underpinnings

In this section I aim to establish the validity of my methodology by tracing its origin from the beginnings of scientific method..

3.2.1 BACON AND SCIENTFIC METHOD

Francis Bacon effectively established scientific method with an approach based on the supremacy of observational evidence (Cohen and Manion, 1994 p. 3). He attempted to go beyond ‘induction by enumeration’ where the validity of universal statements is established simply on the basis of an overwhelming number of similar cases (Russell, 2000 pp. 527-528). He rejected the syllogism as a tool for advancing science and suggested instead that an objective, disinterested observer should investigate the world by making careful, systematic lists of large numbers of similar (and dissimilar) cases. Theory was to emerge inductively from hunches (hypotheses) tested by finding common factors in these plentiful observations and validity was to be tested (deductively) by testing emergent theory to see if it fits observations made in unfamiliar environments. Bacon regarded laws derived from direct observations as having the lowest degree of generality and supposed that a hierarchy of generality (and validity) could be derived from aggregated lower-order generalisations (p. 528).

3.2.2 POPPERIAN METHOD

Baconian method was refined by generations of scientists and went without serious challenge until the 20th century when Karl Popper targeted its inductive weakness. In an often-quoted statement he observed that a single exception entirely invalidates an otherwise general ‘law’:

> ‘No matter how many instances of white swans we may have observed, this does not justify the conclusion that all swans are white’ (Popper, 1959 p. 27).

Popper’s principle of falsifiability is a deductive approach to testing the validity of theories by deliberately searching for exceptions:

> ‘First there is the logical comparison of the conclusions themselves, by which the internal consistency of the system is tested. Secondly, there is the investigation of the logical form of the theory, with the object of determining whether it has the character of an empirical or scientific theory, or…it is…tautological. Thirdly there is the comparison with other theories, chiefly with the aim of determining whether the theory would constitute a scientific theory should it survive our test. And finally there is the testing of the theory by way of empirical applications of the conclusions which can be derived from it’ (Popper, 1959 pp. 32-33)

Popper identified three kinds of real knowledge: World 1 empirical knowledge (W1), World 2 personal convictions (W2) and World 3 theoretical knowledge (W3). Of these, W1 empirical knowledge does not require validation because it is true within the limits of perception, W2 personal convictions are internally valid to an individual so not disprovable and W3 knowledge is provisional theory that is susceptible to being disproved (Magee, 1982). This could be (mis)interpreted as an objectivist call to bypass the unsafe personal convictions of W2 and to do data collection in W1, whilst knowledge generation is the exclusive domain of W3. However, for qualitative research, much of the really important data lies in W2 because it consists of human convictions and images. Indeed, much qualitative theorising is also based in the subjective W2 and as such the outputs of qualitative studies are often in the form of narratives which themselves require subjective interpretation: see Mason's chapter *Making Convincing Arguments with Qualitative Data* (2002 pp. 173-204).

One solution to this problem lies in seeing W2 as the critical subjective domain wherein W1 objective observations of human behaviour are developed into ideas and concepts which can then enter W3 for knowledge building (Hill, Cummings and van Alst, 2003). Thus W1 knowledge passes through W2 into W3 and I have adopted this as the underlying method for determining truth in the research.

3.3 The nature of educational research

Cohen and Manion's third means of discovering truth uses Kerlinger's definition of research:

> …the systematic, controlled, empirical and critical investigation of hypothetical propositions about the presumed relations among natural phenomena. (Cohen and Manion, 1994 p. 4)

The methods and literature of educational research were seen as an appropriate context, notwithstanding the predominantly school-based focus of the bulk of educational research (Halpin, 1998). Pring observes that educational research is widely criticised as generally ineffective and that the usual reasons advanced for this by its critics are the lack of rigour in its methods:

> …educational progress is seen to have been 'slow and unsure' because of this failure to be truly scientific, relying upon unreflective experience, common sense, 'subjective' views, untested opinion (Pring, 2000 p. 32)

Pring notes that the widely acknowledged great difficulty of establishing causal links between phenomena in the social sciences has not prevented critics of educational research from insisting that the attempt should be made (Pring, 2000 pp. 61-65). In fact, much effort has been expended to find research methodologies that will yield real and demonstrable improvements in educational practice. Methodologies in educational research are often based on standard tools in the qualitative toolkit such as ethnographic approaches, action research, grounded theory, discourse analysis and convergent interview. These tools are widely used and are documented in standard reference works (see, for example, Cohen and Manion, 1994; Denzin and Lincoln, 2000; Denzin and Lincoln, 2003; Miles and Huberman, 1994)

Hargreaves sparked a vigorous debate in his 1996 lecture to the Teacher Training Agency (TTA) which drew unfavourable comparisons between education and fields of research such as medicine. He asserted that the output of most educational research conducted by universities has little direct application to the day-to-day issues faced by classroom teachers and criticised educational research for its lack of rigour , noting the success of randomised controlled tests that medical researchers have long used in the development of new medical treatments. He suggested it was time education researchers adopted similar standards of rigorous evidence-based research (Hargreaves, 1996).

Hammersley (amongst others) rejected Hargreaves' criticism on the grounds that education can not use the methods of, say, randomised clinical trials in medicine because it deals with cases that are all unique, so that what works well in one educational setting may not work so well in another superficially similar setting (Hammersley, 1997). Others have defended educational research on the basis that attacks such as Hargreaves' miss the point, because the proper function of educational research is rather to provide a 'theory of educational practice testable by experiments of teachers in classrooms' (Stenhouse quoted by Halpin, 1998 p. 5). According to this model, the educational research enterprise could be seen as a partnership where educational theorists in higher education provide inductive theory that is in turn tested deductively by educational practitioners. This appears, on a macro scale, to be compliant with the hypothetico-deductive scientific model.

3.4 Research Paradigm

3.4.1 LOCATING THE RESEARCH PARADIGM IN THE STUDY

Most research paradigms legitimise the use of alternative methodologies, each of which may in turn draw on a number of possible data collection and interpretative methods. Moreover, the same methodologies may legitimately be used in different research paradigms (Figure 9).

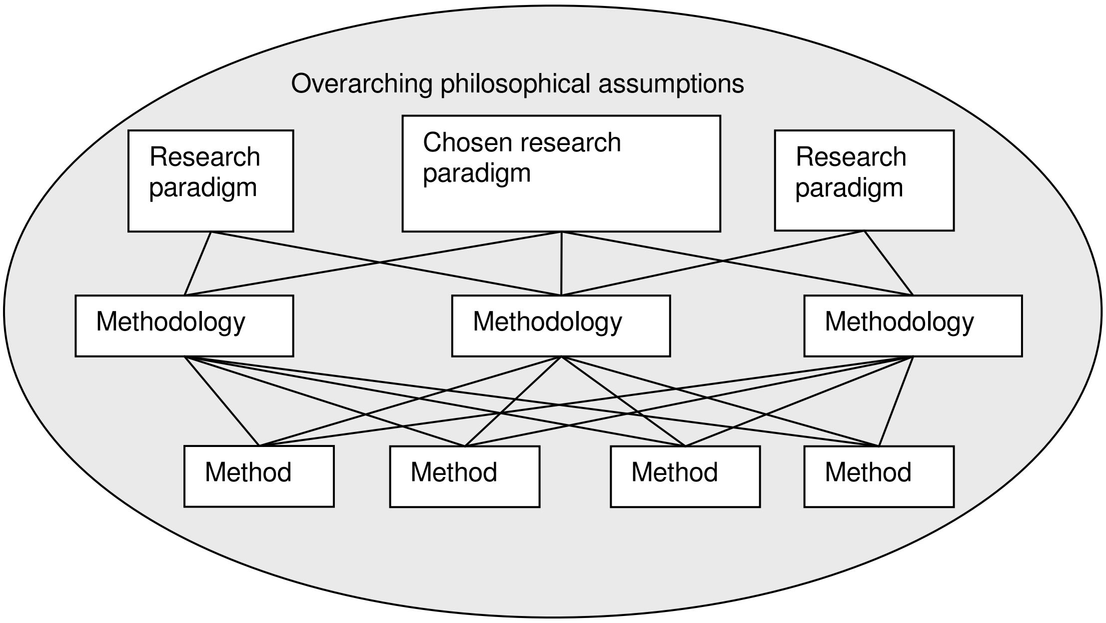

Figure 9- Research paradigms in methodological hierarchies (adapted from Dick, 1993)

Research paradigms are themselves rooted in philosophical assumptions (Cohen and Manion, 1994). The next sections describe how an appropriate philosophical standpoint was established and how a suitable research paradigm was arrived at.

3.4.2 SELECTING A PHILOSOPHICAL POSITION

Social science research textbooks generally distinguish between two opposing traditions in social science research: objectivist and subjectivist (Cohen and Manion, 1994), also called positivistic and phenomenological (Miles and Huberman, 1994 p. 8). Other terms used almost as synonyms of phenomenological are ‘interpretivist’ (Mason, 2002 p. 2) and ‘constructivist’. These opposite poles are distinguishable on ontological, epistemological, methodological and ‘human nature’ grounds. I have added a ‘viewpoint’ dimension (Figure 10).

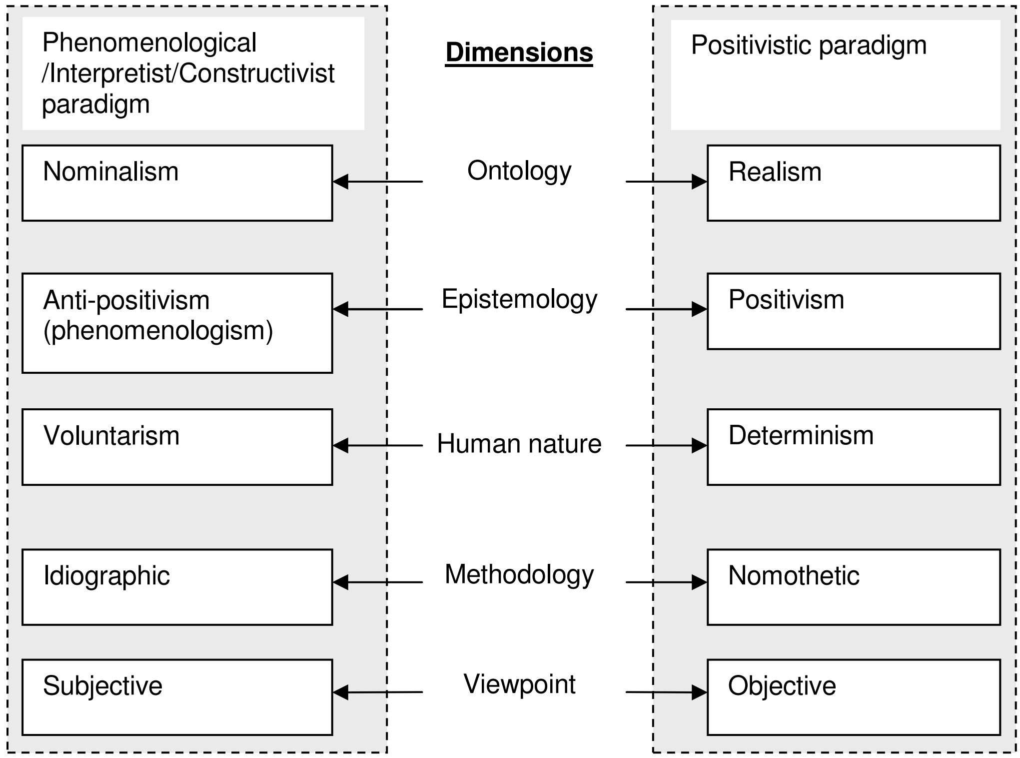

Figure 10- Social science assumptions (adapted from Burrell and Morgan, 1979)

These approaches to social science research are often presented as simple dichotomies: methodologies are supposed to be one or the other. However Burrell and Morgan themselves see these strands as continua:

> "… in practice there is often a strong relationship between the positions adopted on each of the ... strands" (Burrell and Morgan, 1979, p7).

Therefore different positions may be selected on the various dimensions provided they are justified. The research must be located accordingly to philosophical assumptions and a position within Burrell and Morgan's dimensions seems appropriate. This research was undertaken in the belief that reality as perceived by individuals (such as survey respondents) is subjective, of many different viewpoints, so is positioned near the nominal end of the ontological dimension. The view of human nature taken has features of both Voluntarism and Determinism, because it was expected that respondents would be talking about their previous experience, their present concerns and their future plans. Subjects' pasts might deterministically colour their present perceptions and their actions might be circumscribed by local conditions, but their future plans would be at least to some degree within their own hands.

Because the data would be the opinions of individuals, a position at the idiographic end of the Methodological dimension was initially chosen. A UK survey along the lines of the CAA Centre survey (Bull, 1999) would furnish enough data for tests of statistical significance and since the study was intended to be large enough that the findings should be widely applicable this indicated a nomothetic character in the research. Therefore, a position between the idiographic and nomothetic poles has been adopted. The viewpoint selected was subjective, because I expected to interact with respondents in interviews. This could be broadly characterised as a version of Interpretism where emergent theory is validated by Popper's 'three world' approach to knowledge building and has been adopted as the theoretical paradigm for this research.

3.4.3 LOCATING THE RESEARCH PARADIGM WITHIN THE FIELD

To summarise, the research might be epistemologically characterised as phenomenological in approach because the data would be qualitative, rich and subjective, with relatively small samples and the locations are 'in vivo'. The research is concerned with theory generation and it was intended that the theory would be generalisable. There was a positivistic tint in that the survey sample size was possibly large enough to allow some general conclusions to be drawn about the opinions of CAA practitioners and experts generally. These features of different kinds of qualitative research were characterised by Hussey and Hussey (1997) according to data type, sample size, method, location, reliability, validity and generalisability (Table 3).

Phenomenologist paradigm	Features	Positivistic paradigm
Tends to produce qualitative data Data is rich and subjective	Data type	Tends to produce quantitative data Data is highly specific and precise
Uses small samples	Sample size	Uses large samples
Concerned with generating theories	Method	Concerned with hypothesis testing
The location is natural ('in vivo')	Location	The location is artificial ('in vitro')
Reliability is low	Reliability	Reliability is high
Validity is high	Validity	Validity is low
Generalises from one setting to another	Generalisability	Generalises inductively from sample to population

Table 3- Features of research paradigms (adapted from Hussey and Hussey, 1997 p.59)

The data available were the opinions of CAA experts and practioners, which would be mostly qualitative in nature although some quantitative data was expected such as numbers and types of tests given. A UK survey was intended to collect large numbers of responses,to be comparable with the 1999 UK survey but the number of interviews was expected to be no more than 20. The sample size was mid-way between the two poles, no hypothesis was propsed at the outset of the study and a declared aim was to construct a model for embedding CAA in universities which positioned the research in the Phenomenologist tradition.

The research would be conducted 'in vivo' (another characteristic of phenomenologist research). Respondents would be working members of the academic community. Reliability was expected to be high in terms of the findings from the UK survey because respondents identified similar issues in the earlier 1995, 1999 national surveys (section 2.5.3). I expected validity to be high, because theory would be built on the beliefs and opinions of practioners and experts. I expected the findings to be at least partially transferable to UK higher education institutions, although not necessarily to other UK educational settings or outside the UK where conditions might differ. A methodology was sought that would accommodate these underlying assumptions and the presumed nature of the data.

3.4.4 SELECTING A METHODOLOGICAL APPROACH

Six approaches to combining inductive and deductive analysis for qualitative research were considered (Perry and Jensen, 2001). These are illustrated below (Figure 11).

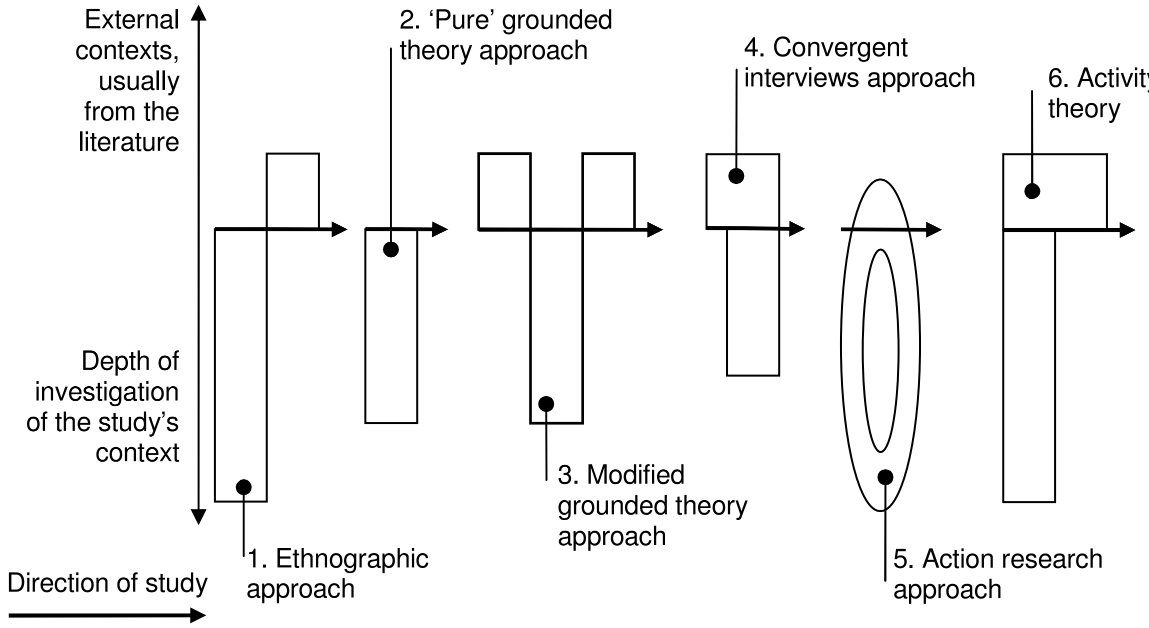

Figure 11- Inductive/deductive approaches to qualitative research (adapted from Perry and Jensen)

Ethnography as a research method is 'grounded in a commitment to the first-hand experience and exploration of a particular social or cultural setting on the basis of (though not exclusively by) participant observation' (Atkinson, Coffey, Delamont, Lofland and Lofland, 2001 p. 4). A purely ethnographic analysis was considered, because I was to be a participant observer in at least one aspect of the field work. It was, however, rejected as unsuitable because a primary aim of the study was to produce a model that described how CAA is adopted in universities. An ethnographic approach would be compromised by a shortage of the extended contact time usually required (the study was to be conducted outside of normal working hours), the consequent obvious difficulty in becoming immersed in actors' everyday life and not least because such approaches are not usually chosen for theory building (although grounded theory has been used for theory building in ethnographic studies- see, for example, Charmaz and Mitchell, 2001). I felt it likely that the study would require the inductive and deductive analysis of both quantitative and qualitative data: ethnographic approaches do not themselves provide a structured way to combine deduction and deduction (Perry and Jensen, 2001 p. 5).

Grounded Theory (GT) in its classic form was first described by Glaser and Strauss in their original (1967) book *The Discovery of Grounded Theory*. Since then Glaser has championed a grounded theory in which a simple trust in emergence is paramount (Glaser, 1992). He continues to defend 'classic' GT as the only legitimate form (Glaser, 2002; Glaser, 2005).

'Modified' forms of Grounded Theory have been proposed which build on classic GT. Some of these embody pragmatic approaches to theory building: for example Perry and Jensen point out that modified forms of GT admit the use of external dimensions, usually from the literature, in conjunction with theory building. They argue that 'pure' forms of GT are impoverished by an insistence on maintaining an artificial professional naivety ('professional distance') until the study is finished (2001 p. 4). Other theorists concentrate on the theory building process and advocate the use of various conceptual 'toolkits'. The best known of these is Strauss and Corbin's approach (Strauss and Corbin, 1990; Strauss and Corbin, 1998a; Strauss and Corbin, 1998b). Some have advocated extensions to Strauss and Corbin's pragmatic approach, such as Axelsson and Goldkuhl's 'action-oriented' 'Multi-Grounded Theory' which provide conceptual toolkits for better visualising emergent theory (Axelsson and Goldkuhl, 2004). Others have concentrated on the underlying 'world view' of grounded theorists: for example, Kathy Charmaz advocates an overtly Constructivist attitude towards theory building - 'Constructivist Grounded Theory' (CGT) which emphasises the subjective nature of both data and theory (Charmaz, 2000). See Glaser (2005) for a detailed rebuttal of CGT.

Action Research (AR) is usually considered suitable for studies where the researcher is an active participant in developing better practice (Hopkins, 2002). AR is an iterative methodology often used to secure improvements in localised practice by applying lessons learned in earlier iterations. It usually starts with a general question - 'how can we improve our practice?' which is answered by first approximation ('fuzzy') methods that produce successively better answers as all three are progressively refined (Figure 12).

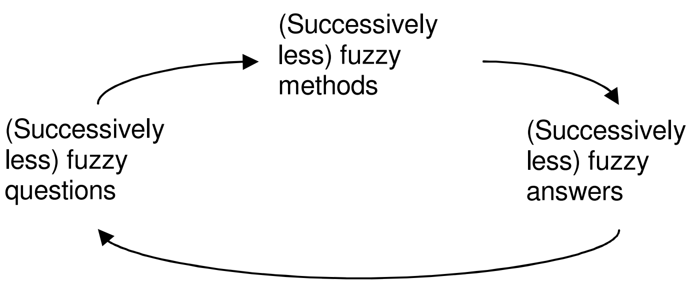

Figure 12- Action Research (after Dick, 1993)

An AR methodology was considered, but was rejected as inappropriate to a study like this which was intended to produce generalisable findings: the whole point of an AR study is that it should improve practice within the peculiar conditions of a local research *milieu* (Hopkins, 2002). It was also relatively poor in analytic tools (Perry and Jensen, 2001).

Convergent Interview (Figure 13) is an iterative technique whereby a series of interviews is conducted, but only overlapping data are considered. If the informants are in agreement, later cycles test the agreement; if disagreeing, later cycles attempt to explain the disagreement (Dick, 1998; Dick, 1993). The Convergent Interviews approach was rejected as insufficiently rigorous and lacking theory building tools (Perry and Jensen, 2001).

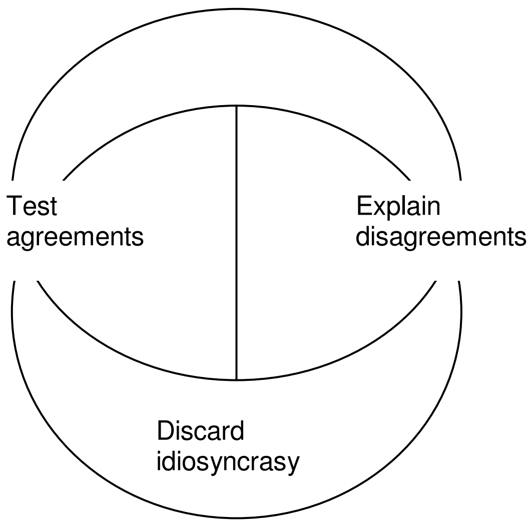

Figure 13- Convergent Interviews approach (after Dick, 1993)

Activity Theory is derived from the view that human experience is rooted in social interaction and is based upon the work of Vygotsky, Leont'ev and Luria (Hedegaard, Chaiklin and Jensen, 1999). Interactions occur between an individual (subject) and an object; other interactions are mediated by tools which include all kinds of abstractions (ideas) and concrete artefacts (such as a hammers or computer systems). This is referred to as a Mediational Triangle: activity triangles are extensions of this general model which illustrate the ways individuals in communities perform tasks (acti*vities*) aimed at achieving specific targets (*objects*) (Figure 14).

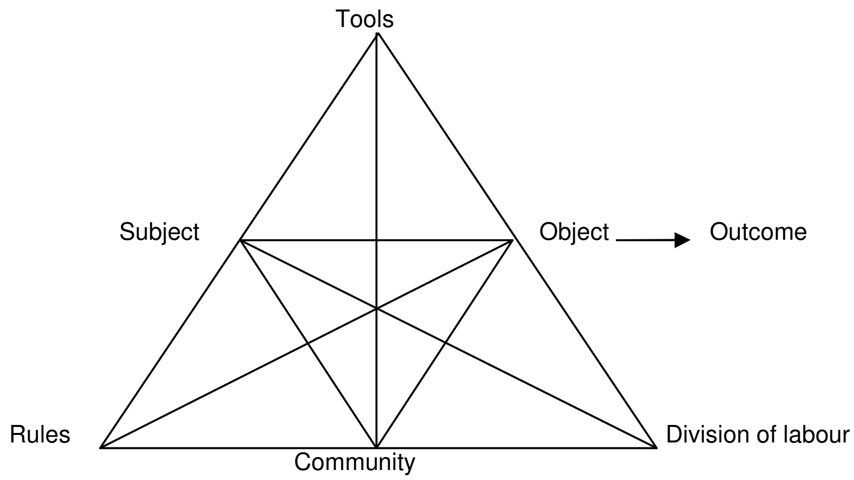

Figure 14- An Activity Triangle

Objects are abstract and/or concrete goals shared by a *rule* - bound community, the manipulation or mediation of which by some *division of labour* are *outcomes*. Thus activity theory provides a framework for describing complex relationships existing when a community undertakes an activity, but for complex and extensive communities such as universities where there is a very high degree of complexity a way has to be found to make the analysis manageable. The literature describes ways of doing this, all of which require picking a specific sub-set of the problem at a relatively early stage in the study and analysing it separately from the main body (for some recent examples in educational research, see Daniels and Cole, 2002; Fullick, 2004; McAteer and Marsden, 2004).

Activity theory was considered for this study because it has many of the attributes required. It provides a strong analytical framework that appears well suited to problems involving group behaviour and has some credibility as a rigorous research tool in the sense that it has been used in some well-placed educational research papers and in at least two recent successfully-defended PhD theses (Fullick, 2004; Hakkarainen, 1998). It was judged to be weak in theory building and better suited to relatively well-defined activities such as computer-mediated communication rather than the complex topic of changes in university assessment practice which includes layers of management, organisational change and project risk management.

3.5 A grounded theory approach

I concluded that a form of GT approach was best suited to the research process envisaged, because it has been used successfully in research studies of both large systems (Tillmann, 2003) and organisations (Harwood, 2002). It provides a well-established set of theory-building and analytical tools (Strauss and Corbin, 1998a). In particular, when positioned against activity theory, it has the apparent advantage for this study that concentrating on core concepts can happen at a later stage in the analysis. This allows a longer period for reflection and promotes 'theoretical sensitivity'. 'Selective coding' is described in by Strauss and Corbin (1990; 1998a).

The nature of GT is contentious due to differences that grew up between the co-authors (Glaser and Strauss) of the original text *The Discovery of Grounded Theory* published in 1967. Both argued for a 'rationale of theory that was *grounded* - generated and developed recursively through interplay with data' as Strauss and Corbin put it most recently (1998b p. 162). This approach was seen as revolutionary because it challenged the dominant quantitative model in social science research both in terms of its 'artificial' divisions between theory and research and in the inferior role assigned to qualitative research (Charmaz, 2000 p. 511).

Grounded theory has bifurcated roots in the rigorous positivist traditions that Glaser grew up with and in the empirical traditions of Chicago school field research and Herbert Blumer's symbolic interactionism of Strauss' upbringing (Charmaz, 2000 p. 512; Strauss and Corbin, 1998a p. 8). The result was that GT combined Glaser's deductive attitude to data analysis, with Strauss' inductive methods which yielded an iterative deductive/inductive 'successive approximation' approach to theory generation.

After publication of *The Discovery of Grounded Theory* Glaser and Strauss appear to have worked separately. Glaser developed the theoretical side of GT in his 1978 book *Theoretical Sensitivity*, while Strauss developed a more 'hands-on' approach in his 1987 book *Qualitative Analysis for Social Scientists* (Charmaz, 2000 p. 512). The differences between them became more obvious with the first edition in 1990 of Strauss and Corbin's *Basics of Qualitative Research: Grounded Theory and Procedures and Techniques* and Glaser's (1992) retort *Basics of Grounded Theory Analysis: Emergence vs. Forcing*. Strauss and Corbin took the view that GT should be verificational and legitimately influenced by the researcher's existing ideas, but Glaser insisted data must be acquired without 'forcing' it into pre-existing frameworks or pathways: 'Categories emerge upon comparison and properties emerge upon more comparison. And that is all there is to it' (1992 p. 43). By 1992 the split was unbridgeable:

> After… 1991 the exchange of letters ensued with myself pleading and Anselm saying 'no' to a pulling and correction of Basics of Qualitative Research. (1992 p. 3)

Although Glaser's avowed intention for the 1992 book was to produce a basic text for 'yeoman researchers', he also makes it clear that a primary purpose of *Emergence vs. Forcing* was to correct what be sees as basic errors propagated by Strauss and Corbin in *Basics.* He targets the first edition of *Basics* chapter by chapter: 'This book follows the exact chapter sequence and nomenclature in Basics of Qualitative Research…' (1992 p. 10)

The second (1998a) edition of Strauss and Corbin's Basics of Qualitative Research acknowledges Glaser's contribution to the development of GT up to 1978 but appears to ignore his 1992 riposte apart from a single mention of its existence (1998a p. 9). In their introduction to the second edition Strauss and Corbin reject Glaser's accusation of allowing preconceptions to pollute theory generation: they insist that in 'their' GT, a researcher 'does not begin a project with a preconceived theory in mind'. However, they permit this provided the purpose is to "elaborate or extend existing theory" (1998a p. 12). The differences between the two could be summarised by saying that Glaser's GT comes from a 'purist' approach that relies on an 'open' attitude to the research enterprise where the researcher is 'professionally naïve': in this way, theory generation is not compromised by researchers' prejudices but emerges directly from the data. The split between these two accounts is illustrated below (Figure 15).

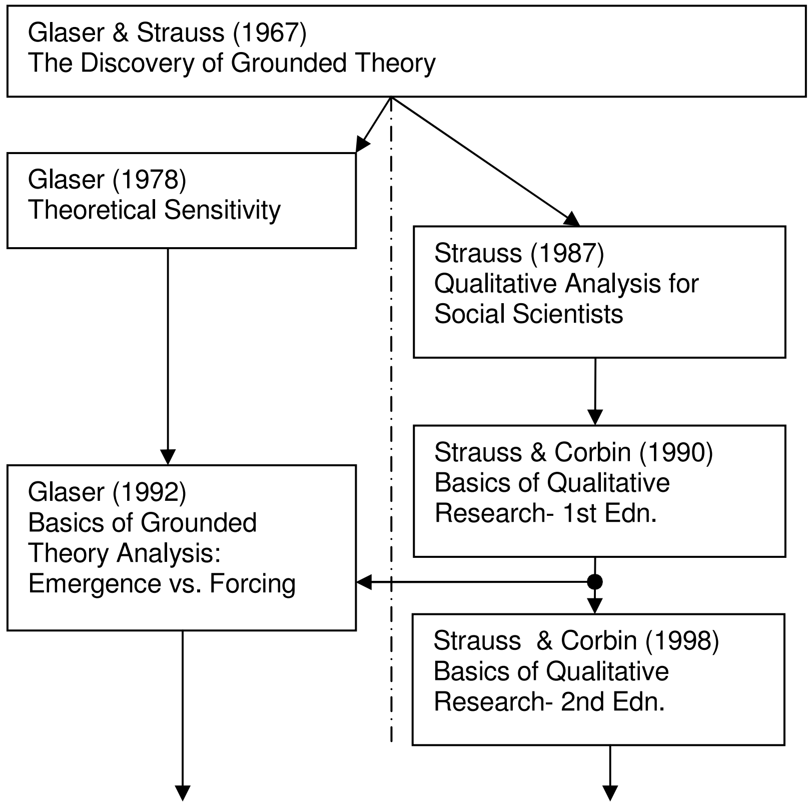

Figure 15- Key stages in grounded theory development (after Harwood, 2002)

In contrast, Strauss and Corbin's GT is a 'pragmatic' approach with a more 'structured' attitude to theory building. It prescribes the use of a set of analytical tools and guiding principles (1998a p. 13). The researcher is encouraged to mix GT with other methodologies (1998a pp. 28-33) and to apply existing insights and experience where appropriate (Figure 16).

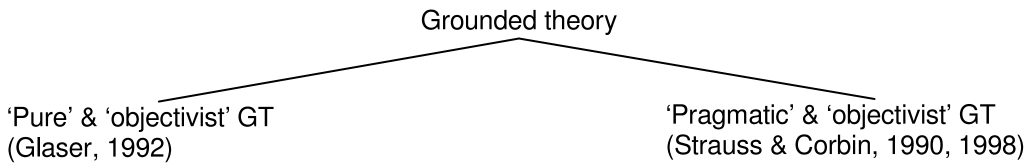

Figure 16- Principle strands of grounded theory (after Harwood, 2002)

Both accounts of GT share a recursive approach to data collection and analysis where each round of data collection is conditioned by what has been learned in the preceding round of data analysis (Figure 17).

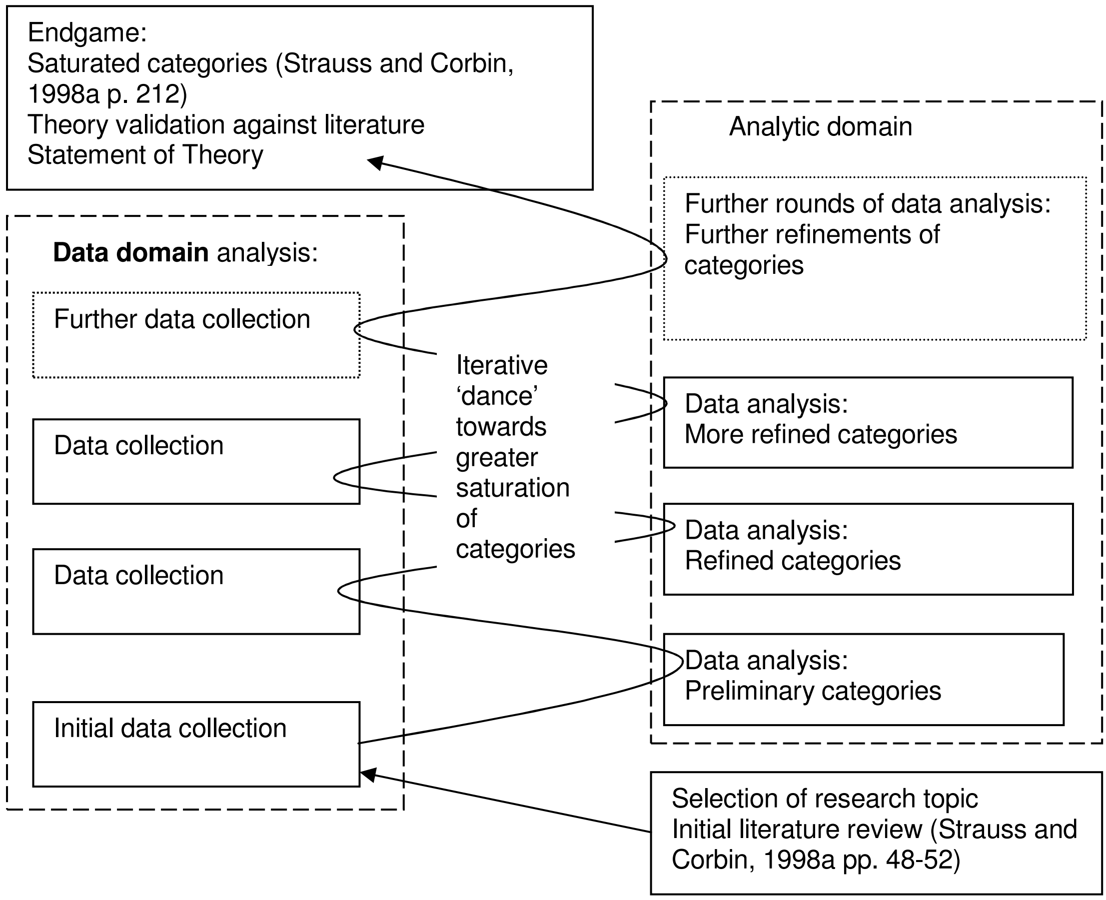

Figure 17- Grounded theory 'data dance' (adapted from Kelsey, 2003)

This 'data dance' proceeds recursively so that theory is progressively refined, until a point of theory saturation is reached (Kelsey, 2003; Strauss and Corbin, 1998a p. 212). Glaser's approach places much less emphasis on the deductive phase:

> In grounded theory the analyst just lets concepts emerge and their theoretical codes emerge, which becomes hypotheses - induction - and then maybe for theoretical sampling, conceptually elaborates a bit to get more data on a thin area through more data collection. Grounded theory is induction from data, with a bear (sic.) minimum of deduction from the emergent, to further data collection. (1992 p. 85)

Charmaz claims that Glaser, with his 'purist' insistence on the paramount importance of professional naivety, 'assumes that we can gather our data unfettered by bias or biography' (Charmaz, 2000 p. 522). She critiques Strauss' and Corbin's guidelines as 'didactic and prescriptive rather than emergent and interactive' (2000 p. 524) and advocates instead a 'constructivist' adaptation to GT. This represents a third strand of GT which Charmaz positions between the post-modern positions of Denzin (among others) and the post-positivist position of Rennie (2000). The constructivist adaptation of Charmaz was considered, but did not appear to add much in terms of validity to the analyses.

3.5.1 SELECTION OF A GROUNDED THEORY METHODOLOGY

This research project was to begin with reading around the topic which led eventually to a peer-reviewed summary of 'key themes' in the CAA literature (Warburton and Conole, 2003a). I envisaged an initial tranche of unstructured interviews conducted with local CAA stakeholders, followed by a small-scale survey of CAA concerns to be piloted amongst an accessible group of CAA enthusiasts. A larger survey by interview and questionnaire (Warburton and Conole, 2003b) was planned to gather further data.

A decision taken at an early stage of the research was to co-develop a scheme for evaluating the TOIA CAA tools along with the research project methodology. I intended that this strategy would facilitate the evaluation of the TOIA project. Reciprocally, I hoped that interviews conducted with TOIA evaluators would contribute data to the development of theory in the present study. The inclusion of 'external' data was a consideration in selecting the methodology. I thought Strauss and Corbin's approach would be well fitted to this study due to its more inclusive attitude to existing data:

> Essentially, working with already collected data is no different from doing secondary analysis on one's own data or on someone else's data - perhaps long since collected… The major difference, perhaps, is that with personally collected materials, the researcher has some familiarity with the materials. (Strauss and Corbin, 1998a pp. 281-282)

It also has a structured pragmatic approach and comes with a set of ready-made analytical tools. Another reason for rejecting Glaser's approach was that I could not credibly maintain a naive stance because I was working in the field, had already seen rich data from earlier UK CAA surveys and conducted a preliminary literature review (Warburton and Conole, 2003a).

3.5.2 STRAUSS AND CORBIN'S APPROACH TO GT

Strauss and Corbin identify three basic kinds of coding in GT analysis. The process begins with open coding where the phenomenon under study is initially categorised by crudely sub-dividing or 'fracturing' the data into categories which represent 'units' of information and are derived from one or more perspectives. Within each category there may be *subcategories* and both of these could have properties. Properties may be *dimensionalised* according to possible sources of variation within the property. Once the data has been fractured in this way, **axial coding** can begin, during which new relationships among the data are discovered. This is usually displayed using a paradigmatic presentation in which central phenomena are described and causal conditions explored. Intervening conditions that influence phenomena are identified and consequences for phenomena are indicated. Then, in selective coding, a narrative is constructed which integrates the categories in the axial coding model. At this stage conditional *propositions* (with many attributes of a traditional hypothesis, but not actually called that) may be proposed. Finally the central concept is related to the environment in which the data was collected and the literature pertaining to it. The outcome of this progression is theory which is *grounded* in the data and which is positioned against the specialist literature.

The challenges faced by grounded theorists include the need to disregard, as far as possible, existing theory in order to leave the path clear for substantive theory to emerge from a GT analysis. There is often some difficulty in determining when the theory is sufficiently mature, although for practical purposes this is usually understood to be when the categories are fully saturated (Glaser and Strauss, 1967; Strauss and Corbin 1998a).

3.5.3 MAKING PROVISION FOR DESIGN CHANGES DURING THE STUDY

Janesick's (2000) dance metaphor is extended to provide for a second stage of design changes made as 'mid-course' modifications to the initial strategy, which she sees as an essential part of the research 'dance':

> My own experiences in conducting ,,, studies have led me to refine and adjust study design constantly as I proceed, especially at this phase (2000 p. 387)

Janesick describes a third and final 'cooling down' stage where design changes may be made to a research project as it winds down:

> The researcher must decide when to actually leave the field setting… Following the process of leaving the field, final data analysis can begin… As Richardson (1994) suggests, narrative writing is in itself a type of enquiry… The researcher must continually reassess and refine concepts while conducting fieldwork… develop working models… [and] verify these… The work is always open to discussion and critique… (2000 p. 389)

In the light of this interpretist/constructivist position, I foresaw a need to adjust the research design during the study. Bearing in mind that the research would be conducted part-time and with minimal physical resources, a flexible approach was taken to data collection in terms of the volume of data and the amount of time that could be allocated to data analysis. These adjustments were made without compromising the methodological integrity of the project.

3.5.4 MOVING INTO THE FIELD

The research aims were agreed with management in the Information Systems Services (ISS) department which sponsored this research. They are reiterated in the introduction to this chapter (Figure 18 stage I).

In GT studies, the data collection (Figure 18 stage III.a) and data analysis phases (Figure 18 stage III.b) proceed recursively with a check being made after each cycle to determine whether the categories are still changing. If they are, the gaps in the evolving theory are identified and addressed through a further round of data collection: if not, a point of theoretical saturation is said to have been reached (Strauss and Corbin, 1998a p. 212) and normal practice is to state the theory produced and to position it within the literature (Figure 18 stage IV).

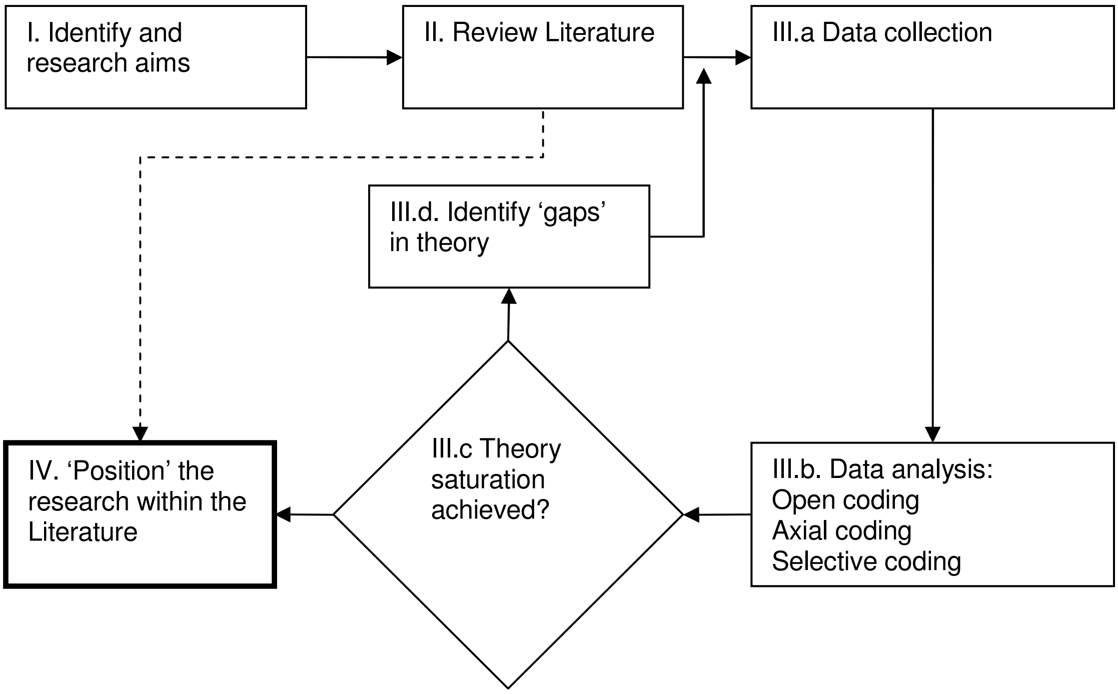

Figure 18- Overview of research process workflow (after Harwood, 2002 p. 69)

3.6 Data collection activities

In this section I describe the data collection process in the context of the GT methodology described earlier. The following section addresses data analysis.

3.6.1 PRIMARY DATA IN GROUNDED THEORY STUDIES

The existing literature, observations and interviews comprise the data substrate in Strauss and Corbin-style GT studies. Strauss and Corbin distinguish between general and technical literature. They define *technical literature* as comprising

> 'professional research reports and theoretical papers … against which one compares findings from actual data', whilst *nontechnical literature* comprises 'biographies, diaries, documents, manuscripts, records, reports, catalogs and other materials that can be used as primary data, to supplement interviews and field observations, or to stimulate thinking about properties and dimensions of concepts emerging from the data' (1998a p. 35).

Glaser and Strauss in the *Discovery of Grounded Theory* mention explicitly 'general literature' and point out that in general, literature should be regarded as useful informational material rather than as primary data:

> In writing up his (*sic*) finished research, he may use these sources as additional reference points, even as secondary data. Even more likely, he will introduce the information in an opening chapter as a prelude to the analysis of his own data, giving the reader a simplified backdrop for the work. General literature is used, then, mainly for informing rather than as data for analysis. (1967 p. 162)

Crucially, they call for the use of a wider range of qualitative data sources than has often been the case, when they go on to say that:

> The extremely limited range of qualitative materials used by sociologists is largely due to the focus on verification. For many, if not most, researchers, qualitative data is virtually synonymous with field work and interviews, combined with whatever 'background' documents may be necessary for putting the research in context... The emphasis on fieldwork and interviews may also rest on a feeling of wanting to see the concrete situation and informants in person (pp. 162-163)

They suggest that in sociological research, documentary evidence is as important in theory generation as field work. In fact they recommend that fossil 'caches' of documentary evidence such as bundles of letters or fragmentary transcripts of conversations should be regarded as equivalent in status to interviews:

> This … suggests that [caches] can be regarded much like a set of interviews, done with either a set of people or representatives of different groups. (p. 167)

It occurred to me that responses to open questions returned in questionnaire scripts had much in common with such 'caches' of documentary evidence. Firstly, they represent the self-reported opinions of people who would under ideal conditions be interviewed. Secondly, such data would be more or less 'structured' as the questions asked would always be the same. In the latest edition of *Basics*, Strauss and Corbin devote much of their third chapter 'Basic Considerations' to data collection. They refer explicitly to the use of questionnaires as one possible alternative to interviews for collecting data:

> Think, as an exercise in imagination, of the many decisions involved in data collecting. Should we interview? What type or types of interview? How many interviews should we aim for and in what grounds? Where will we go to find the interviewees… On the other hand, one might ask, would it make more sense to use questionnaires to collect our data? (Strauss and Corbin, 1998a p. 29)

In this study, it was thought likely that there would be little possibility of dynamic interaction with survey respondents, for instance to follow up interesting comments, because the part-time nature of the research would militate against this. Despite these differences with the traditional ‘live’ data collections of grounded theorists (contemporaneous first-hand observations and interviews) these data nevertheless promised to represent a rich and pertinent source for the opinions of CAA practitioners and specialists. The data could be validated by comparison with transcripts of interviews with similar subjects.

3.6.2 OVERVIEW OF SURVEY ACTIVITIES

Three sources of data were available for the grounded study: an initial review of the existing literature and survey both by semi-structured interview and by questionnaire of CAA stakeholders in UK universities. It was envisaged that emergent theory generated in the grounded study would be validated against the literature and quantitative data obtained in the main surveys. The examples chosen by Strauss and Corbin are interview transcripts, but the same process can be applied to any field observations (Strauss and Corbin, 1998a pp. 281-282). This was interpreted to include free-text responses from questionnaires.

The research was conducted strictly according to the Revised Ethical Guidelines for Educational Research issued by the British Educational Research Association (BERA, 2004). According to the *Guidelines*, researchers have a particular responsibility to preserve respondents’ privacy by ensuring that data is collected in confidence and is anonymised where any part of it is published (2004 para. 23). Respondents were assured that the original raw data would be destroyed as soon as it had been anonymised and coded and that every effort would be made to ensure their privacy. The only form in which their responses would be published - if at all - would be as short anonymised extracts (2004 paras. 24-26).

Data was collected by a sequence of four surveys conducted during the course of the study. The first was an exploratory survey that originated in contact with a group of learning technologists who were widely accepted as CAA experts in November 2002. I outlined my research interests and asked permission to surveying its members about their views on implementing CAA. A short questionnaire was compiled and distributed by email to group members. The results were gathered by email and followed up by face-to-face interviews in early 2003. The interviews targeted concerns which had been identified n the questionnaires.

Data from the 2002 pilot survey was coded and analysed using a GT approach (Strauss and Corbin, 1998a). The categories identified therein were used later in 2003 to prepare a second survey. Feedback received from the 2002 respondents showed that the1999 UK CAA Centre survey might be a more appropriate basis for the 2003 survey because it was a more comprehensive instrument and focussed directly on the uptake of CAA (Warburton and Conole, 2003b). This revised questionnaire was distributed in 2003 by mail list to CAA users and enthusiasts. 150 respondents started the survey and 43 usable responses were received, mostly from enthusiast CAA using academics. The data were analysed (Warburton and Conole, 2003b) and used to inform the questions asked in face to face interviews which were conducted at the 2003 CAA conference.

A decision was made to reissue the questionnaire in the light of comments made by some 2003 respondents and to re-host the questionnaire in order to ameliorate the difficulties found in extracting survey responses from the 2003 reports. However, technical difficulties in re-hosting the survey resulted in a delay until mid-2004. In June 2004 a link to an updated version of the questionnaire was distributed nationally by mail lists to e-learning and CAA users and by letter to QA heads and LT coordinators at all 160 UK universities. This survey attracted an unknown number of attempts, of which 123 full responses were saved and retrieved.

Results from the 2003 and 2004 interviews and the survey free-text responses were pooled. The data were coded according to Strauss and Corbin's 1998 prescription and an emergent theory was generated. A final tranche of face-to-face and telephone interviews was conducted and the categories tested for saturation. The data collection and analysis activities are summarised below (Figure 19).

3.6.3 SURVEY BY QUESTIONNAIRE STRATEGY

It was anticipated that the surveys by questionnaire would provide two kinds of data, namely qualitative data in the form of free text responses to open-ended questions and quantitative date in the form of 'closed' Likert-scale items. For reasons discussed later in Chapter 5 (phase 2 data collection and analysis), the survey instrument was based upon the 1999 CAA Centre survey and it was assumed that data from open-ended questions would be used in theory building (Glaser and Strauss, 1967; Warburton, 2005).

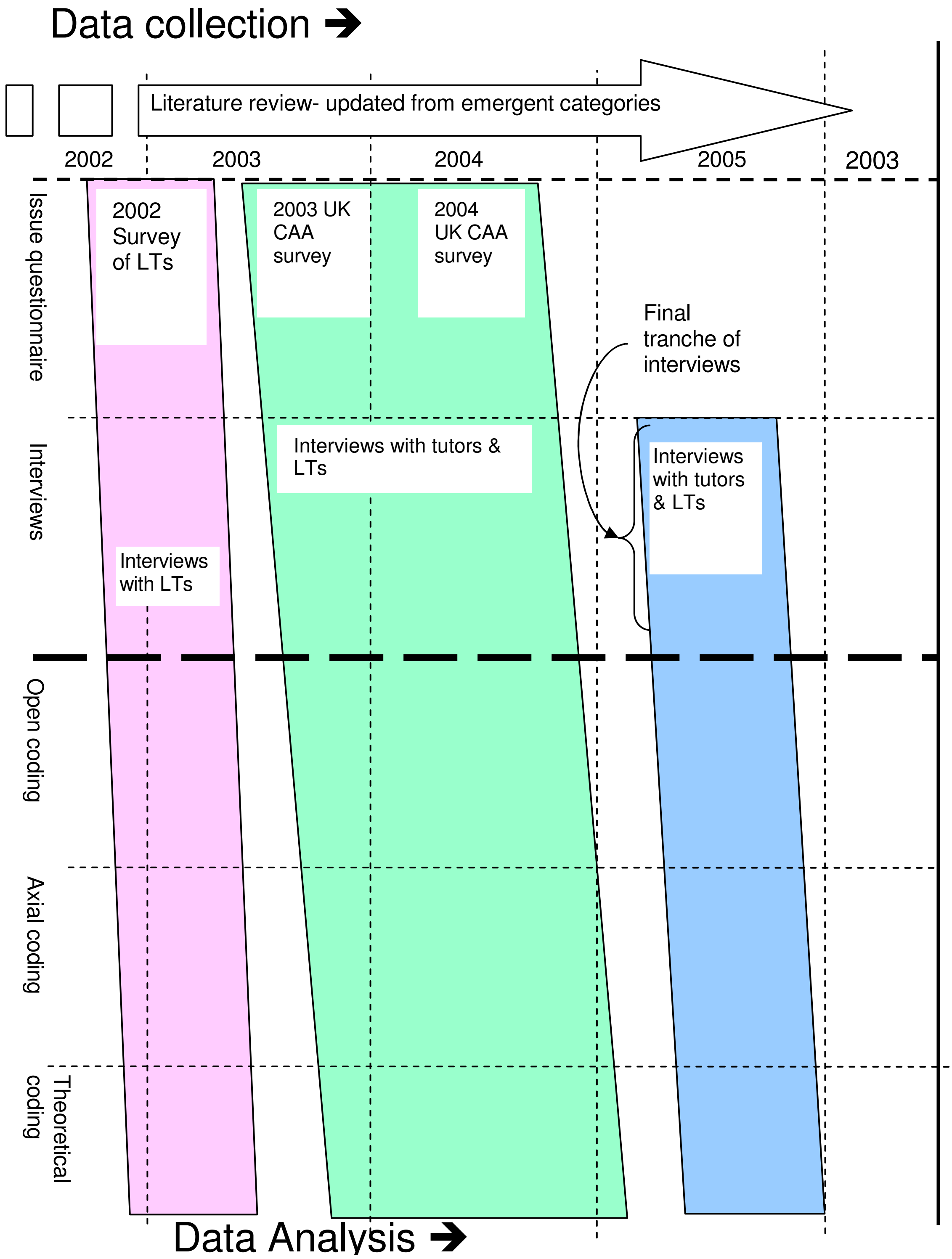

Figure 19- Overview of data collection and grounded theory analysis activities

3.6.4 SURVEY BY INTERVIEW STRATEGY

In rigorous research of any kind, researcher bias must be carefully guarded against and where it can not be avoided, it must be accounted for. This principle was formally stated by Bacon at the beginning of the 17th century (Russell, 2000 p. 528) and applies equally to GT studies (Glaser, 1992; Glaser and Strauss, 1967; Strauss and Corbin, 1998a). One of the main methodological aims was for theory to emerge from targeted discussions with respondents on the basis of what they felt to be important, rather than risking 'leading' them in directions favoured consciously or unconsciously by the researcher. The approaches considered before starting the interviews were structured, unstructured, non-directive and focussed (Cohen and Manion, 1994; Oppenheim, 1992).

A completely structured approach is one where 'the content and procedures are organised in advance… the interviewer is left little leeway to make modifications… it is therefore characterized by being a closed situation' (Cohen and Manion, 1994 p. 273). A fully structured approach was rejected on the grounds that a prescriptive format was incongruent with the aim of allowing discussions to follow respondents' convictions.

In contrast, unstructured interviews are open situations, at the opposite pole to completely structured approaches. Here, 'although the research purposes govern the questions asked, their content, sequence and wording are entirely in the hands of the interviewer' (Kerlinger, paraphrased by Cohen and Manion, 1994 p. 273). A purely unstructured approach would perhaps have been better suited to the kind of GT approach envisaged. I recognised that it would require levels of skill and experience that a part-time, inexperienced researcher might struggle to supply (Coombes, 2001 pp. 96-97). For this reason a semi-structured approach was selected, figuratively nearer the unstructured pole. This arrangement would impose some structure, without preventing interviews from following topics thought important by respondents (Figure 20).

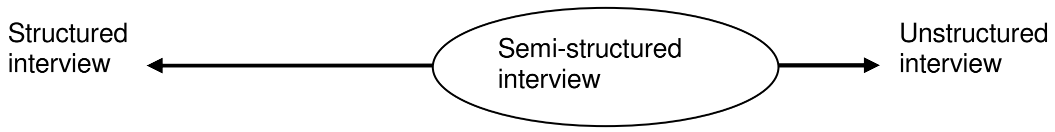

Figure 20- Positioning the semi-structured interview

Semi-structured interviews have been characterised as a 'formal encounter on an agreed subject' (Drever, 1995 p. 13) where the interviewer's questions create the overall structure which is filled in by prompts (broad coverage) and probes (in depth questioning). A mixture of closed and open questions is used and the respondent 'has a fair degree of freedom' about what to discuss. The interviewer 'can assert control when necessary' (1995 p. 13).

The non-directive interview and focussed interview were the other two types of interview considered and can be thought of as being at the poles of different continuum (Figure 21). Non-directive interviewing is derived from therapeutic practice and is characterised by 'the minimal direction or control exhibited by the interviewer and the freedom the respondent has to express her subjective feelings as fully and spontaneously as she chooses or is able'. It is 'an approach… recommended when complex attitudes are involved and when one's knowledge of them is still in a vague and unstructured form' (Moser and Kalton, quoted by Cohen and Manion, 1994 p. 273). Oppenheim advocates non-directive approaches in exploratory interviews to avoid leading respondents along preconceived paths (1992 pp. 74-75).

The focussed interview technique was in contrast developed in order to 'introduce rather more interviewer control into the non-directive situation'. The interviewer pre-analyses a known situation that the respondent was previously involved in and responses are used to substantiate or reject hypotheses (1994 pp. 273-274). Grounded theories are not formulated to test hypotheses (Glaser, 1992; Glaser and Strauss, 1967; Strauss and Corbin, 1998b), so a focussed technique was not adopted in the theory building phases (I and II). The phase 3 interviews were more focussed because the emergent theory was being explicitly validated.

My vocational obligations at the University of Southampton dictated the need for some discussions with CAA practitioners before and during the fieldwork phase of the research. Some of these were recorded and used later in case studies (Shephard, Warburton, Warren and Maier, In press). It was apparent that in many cases, practitioners had indeed not fully articulated their impressions about CAA, but formulated them while they talked. For this reason it was thought desirable to combine an element of non-directivity with the semi-structured interviewing process. This combined approach is depicted below (Figure 21).

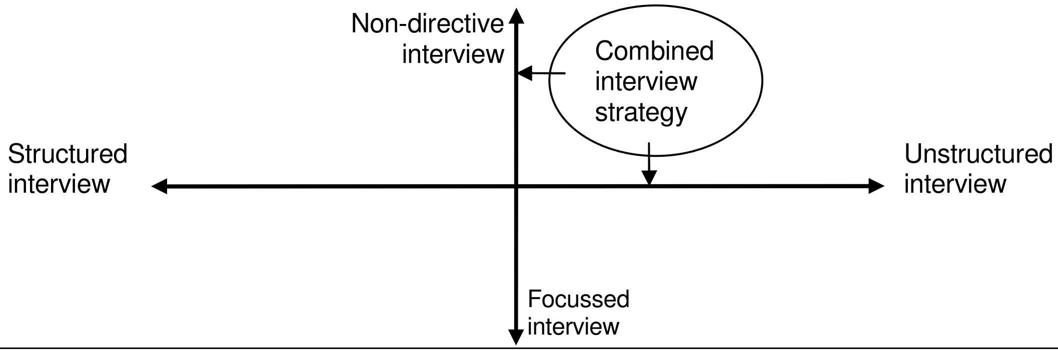

Figure 21- Positioning the combined interview strategy

3.6.5 PHASE 3 DATA COLLECTION

A survey by interview with respondents to earlier surveys was conducted with the aim of verifying the emergent theory that had been built from the data acquired in the first two phases. An interview schedule was compiled according to the principles described in section 3.6.4.

3.7 Data analysis activities

Theory building follows Strauss and Corbin's (1998a) prescription for grounded theories. The basic coding sequence oscillates between primary data and the emerging theoretical framework (figure 15). The codes and categories used to label emergent concepts are derived directly from the data and authenticity is enhanced by the use of *in vivo* codes which are labels named from words found in the data (Strauss and Corbin, 1998a p. 105). When gaps in the data are recognised during analysis, one returns to the field with questions that are designed to fill the gaps and one asks them of people who are well qualified to answer them. This important element of GT is referred to as *theoretical sampling* (Glaser and Strauss, 1967 pp. 45-49; Strauss and Corbin, 1998a pp. 201-215). The different phases of a GT coding sequence are illustrated below Figure 22.

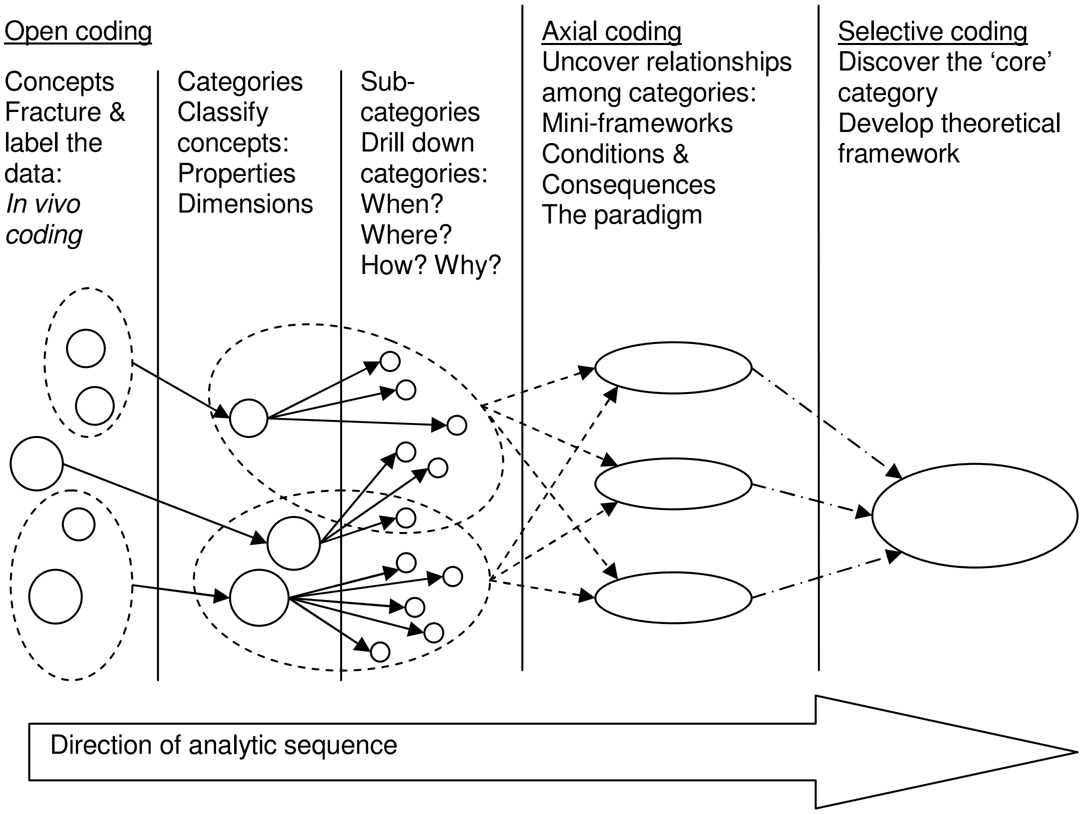

Figure 22- The grounded theory analytic process (adapted from Harwood, 2002 p. 76)

3.7.1 OPEN CODING

Open coding consists of identifying and labelling key concepts (Strauss and Corbin, 1998a pp. 101-105). The examples chosen by Strauss and Corbin are interview transcripts, but the same interpretive process can be applied to, for example, free-text survey responses (pp. 281-282). This seeds axial coding. Memos are recorded throughout the coding process as a way of fixing impressions of what is 'going on' (p. 110). According to Strauss and Corbin, open coding is 'the analytic process through which concepts are identified and dimensions are discovered in data'. Categories are defined as 'concepts that stand for phenomena' identified in the data and dimensions in are the ranges 'along which general properties of a category vary, giving specification to a category and variation to the theory' (p. 101). Open coding is the stage where data is fractured into the smallest possible elements of meaning before being put back together in axial and selective coding. The procedure is to identify and label concepts in the data and then classify them as categories, sub-categories or dimensions depending on their presumed relationships with each other: ‘Before each category was labelled, the researcher tried to stand back and ask ‘what is going on here? And does what I see fit the reality of the data?’ (p. 45). The entire open coding sequence could be illustrated as follows (Figure 23):

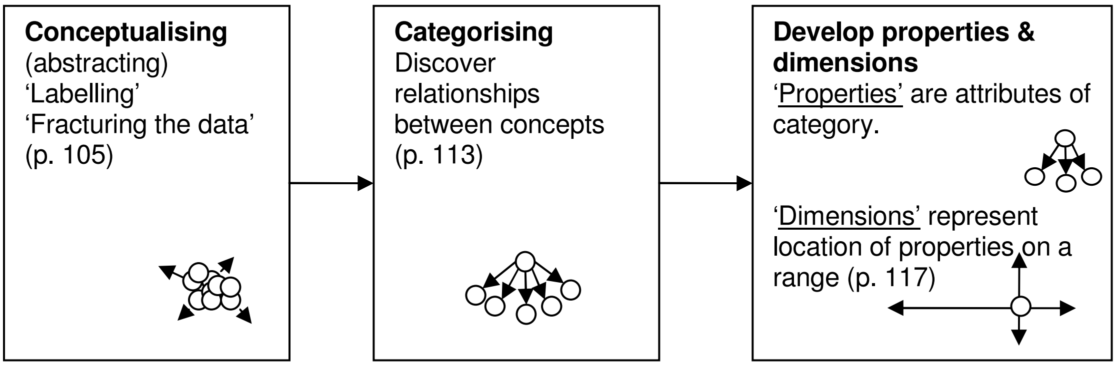

Figure 23- A visualisation of Strauss and Corbin’s (1998) open coding sequence

3.7.2 AXIAL CODING

Axial coding represents an early phase of modelling where relationships between categories and sub-categories are discovered and described. Categories are linked ‘at the level of properties and dimensions’ (p. 123). Categories represent phenomena that have been identified as significant to respondents (p. 124), whereas sub-categories ‘answer questions about the parent phenomenon such as when, where, why, who, how and with what consequences, thus giving the concept greater explanatory power’ (p. 125). Linking occurs ‘at a conceptual level’ rather than descriptively, meaning that concepts arising from the data are related to others that turn out to be their subconcepts according to their logical relationship (p. 126). Strauss and Corbin suggest that axial coding involves the following steps (Figure 24):

Axial coding tasks
Laying out the properties of a category and their dimensions (begins in open coding)
Identifying the variety of conditions, actions/interactions and consequences associated with a phenomenon
Relating a category to its subcategories through statements denoting how they are related to each other
Looking for cues in the data that denote how major categories might relate to each other

Figure 24- Axial coding tasks

Strauss and Corbin distinguish between ‘structure’ as the conditions under which phenomena occur and ‘process’ as the interaction of stakeholders in response to stimuli. They note that ‘structure and process are inextricably linked’ and therefore both must be studied in order to understand how they are related (p. 127). They propose an organisational scheme called ‘the paradigm’ (p. 128) as a tool to assist in making relationships explicit (Figure 25).

Component	STRUCTURE				PROCESS	
	Causal conditions	Phenomenon under study	Context	Intervening conditions	Actions/ Interactions	Consequences
Description	Causes for the studied phenomenon	A category- usually a main theme of the research	Circumstances that underlie the studied phenomenon	Things that change the studied phenomenon	How people handle the conditions - strategic or routine responses	Outcomes of actions and interactions - may be intentional or otherwise
Questions to ask	Why? Where? When?				Whom? How?	What happened?

Figure 25- Strauss and Corbin's paradigm

The analyst distinguishes between categories according to whether they can be classified as conditions, actions/interactions or consequences. The aim is to find explanations rather than rigidly code according to abstract headings (p. 129). An interpretation of this scheme is shown below (Figure 26). The paradigm does not *necessarily* describe causal relationships (p. 130).

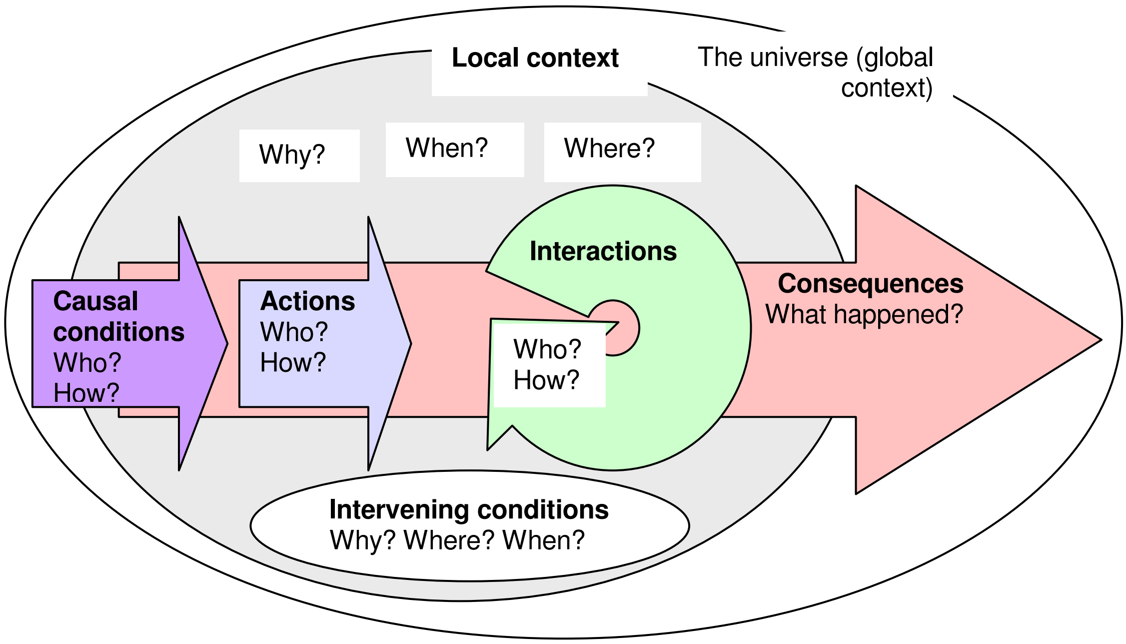

Figure 26- A visual interpretation of Strauss and Corbin's paradigm

Crosscutting is a technique for differentiating categories according to their relationships with subcategories. Strauss and Corbin suggest this is useful when distinguishing between phenomena that appear to be superficially similar (p. 126). *Mini-frameworks* are a way of visualising the results of 'coding around a concept' including cross-cuts (p. 141).

Mini-Frameworks as described by Strauss and Corbin are a diagrammatic means to represent the cross-cutting interaction of major concepts at the level of their dimensions (Figure 27). An illustration is given below where bold lines represent the dimensions of core concepts and others are subordinate concepts related to the core concepts (p. 141).

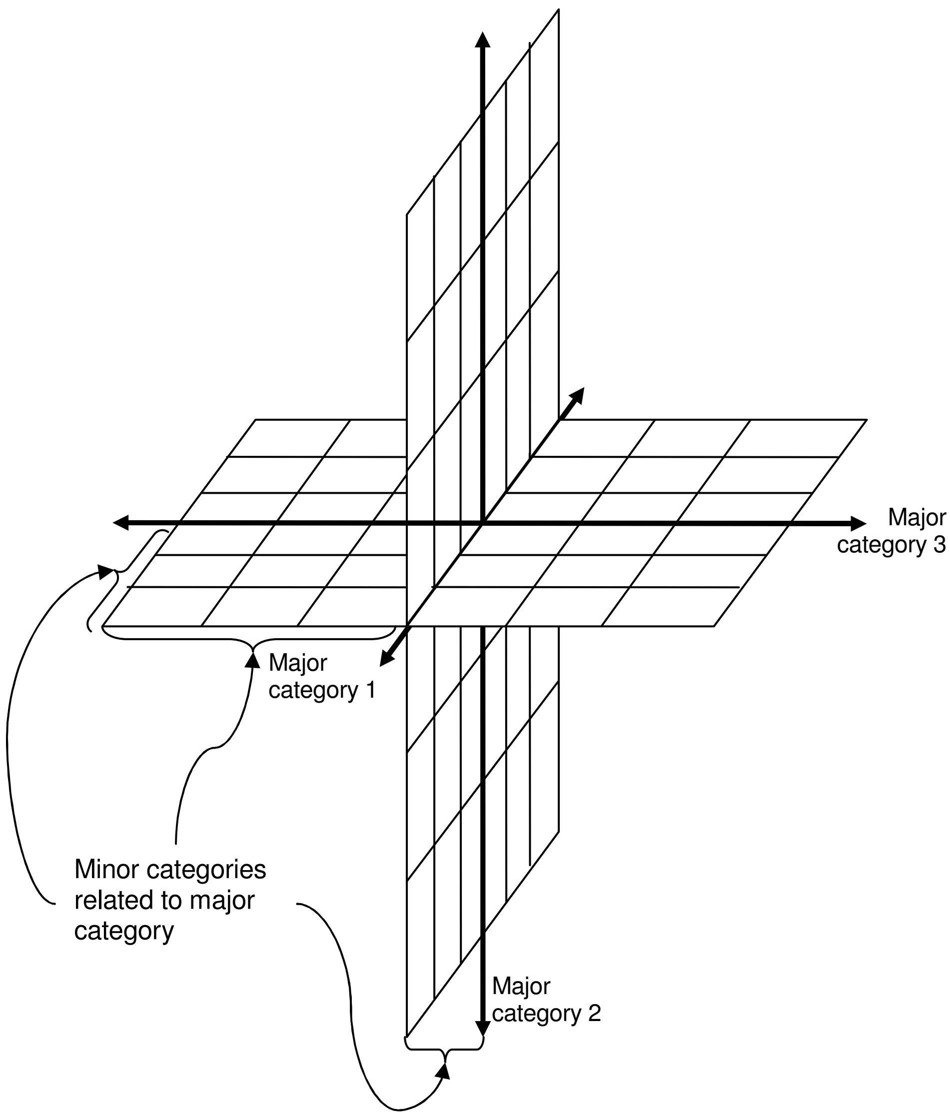

Figure 27- Strauss and Corbin's Mini-Framework (after Harwood, 2002)

3.7.3 SELECTIVE CODING

Selective coding is a subsequent modelling phase where one or more central 'core' categories are identified. The relationships between core categories and other categories lead to emergent theory which may be tested by further rounds of data collection and analysis. Strauss and Corbin define selective coding as 'the process of integrating and refining categories' (p. 143). It is during this stage that theory emerges from data (p. 144).

3.8 Sequence of data collection and analysis

Data collection and analysis activities were performed in three stages, each of which ended with theory-building (selective coding):

- Phase 1: an initial pilot that would comprise a small scoping survey by questionnaire combined with a small number of follow-up face-to-face interviews

- Phase 2: a national online survey combined with a larger number of follow-up face-to-face interviews
- Phase 3: validating and refining the emergent theory by interviews with well-placed experts

This iterative sequence was intended to generate an increasingly refined theory of the way that CAA is taken up in universities.

3.9 Chapter summary

This chapter comprises the focal theory section of the thesis. It began by stating a set of philosophical assumptions that underpin the research. This led to a summary of the development of scientific method up to the time of Popper, whose contribution to scientific method is applied to the context of qualitative research generally and educational research in particular. It delineated the reasons for selecting a particular kind of GT approach and outlined the sequence of data collection and analysis activities. The next chapter describes the first phase of GT data collection and analysis.

4 Phase 1 Data Collection and Analysis

This chapter comprises the first part of the data theory section. It portrays the data collection and data analysis that was undertaken during the first theory-building iteration. The activities undertaken during the second and third iterations are described in the next two chapters.

4.1 Introduction

The initial research question prompted sub questions as described in chapter 3 (Figure 28) which were used to develop the data collection instruments.

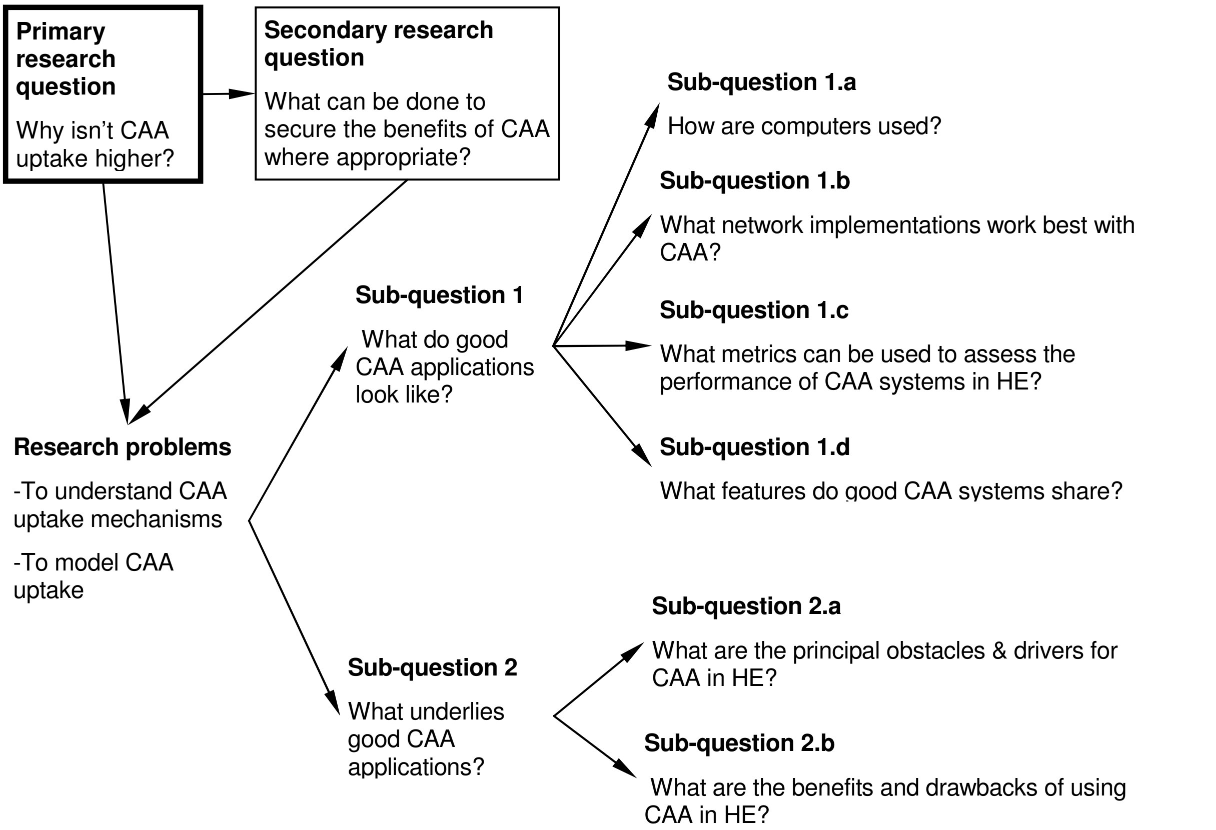

Figure 28- Research questions, research problem and sub-questions

It should be noted that the phase 1 open and axial coding is presented in considerable detail. However, this requires a significant volume of descriptive writing which is justified here on the grounds that the amount of data analysed in phase 1 is small compared to the other two phases, particularly phase 2. This detailed account illustrates the approach adopted in the two later phases of analysis and makes the number of categories discovered more manageable and better suited to use as an example of the procedure used in the other two phases of analysis. The phase 1 data collection and data analysis was as highlighted earlier in the context of the whole study (Figure 19).

Two UK surveys in 1995 and 1999 helped to populate some of the initial categories, most notably concepts of drivers and drivers to uptake (Bull, 1999; Stephens and Mascia, 1997). It should be stressed that although some elements of the categories described below are foreshadowed in the literature, the categories described here nevertheless emerged from the phase 1 data in the manner advocated by Strauss and Corbin. The earlier surveys provided the general context for the phase 1 data collection and analysis exercise.

4.2 Phase 1 scoping survey

The adoption of CAA can be considered at national, institutional, departmental or individual levels of organisation. I decided to begin with a scoping survey of several institutions because this appeared to be a superset of the factors I might also be examining at departmental or individual level. The opportunity arose to pilot an early version with learning technologists who were experienced, widely known and well-regarded as CAA experts. It was thought that survey tools such as this benefit from being piloted on a small scale in a population similar to the target population and since the group members were *de facto* CAA pioneers, this seemed a good place to start. The group comprises learning technologists from both higher education and FE institutions, of which five and one respectively replied in time to be included in the survey.

To shorten development time, the Phase 1 scoping survey tool was based on an audit tool supplied by the JISC Committee for Awareness, Liaison and Training (JCALT) career development study to UK universities. It was designed as a self-completion questionnaire to benchmark the roles and functions of learning technology staff in UK universities, an application which has much in common with benchmarking the use of other computer-based technologies such as CAA. This tool was previously tried, tested and validated during its use by 23 UK universities (Beetham, 2001 p. 1) and was updated in 2003 under the JISC's Embedding Learning Technologies Institutionally (ELTI) program (Timmis, 2003; Timmis, Beetham, Bailey, Conole, Jones and Gornall, 2003). Of the 12 JCALT tool's factors 11 were adaptable to the auditing of CAA penetration (Beetham, 2001 pp. 7-9) and were grouped in the original categories of institutional culture, infrastructure and expertise (Table 4).

Culture: does the institution commit real resources to CAA?	
1	Institutional profile of CAA
2	Profile of CAA support services
3	Recognition and reward of innovation in CAA
4	CAA R&D
Infrastructure: to what extent has the institution integrated CAA into its practice?	
5	CAA infrastructure
6	CAA support
7	CAA funding
8	Administrative infrastructure
Expertise: What CAA skills and experience do the institution's staff and students have?	
9	Staff use of CAA
10	Student use of CAA
11	Networks & collaboration

Table 4- Phase 1 scoping survey- Initial register of factors concerning CAA penetration

The questionnaire was circulated by email to a JISC specialist CAA-related project mailing list. As participants in a JISC-funded project, respondents were judged to be well-informed and capable of giving authoritative responses. The sample size was deliberately made small, because outputs from the phase 1 survey were expected to be limited to a 'snapshot' of CAA practice in some of the more CAA-active institutions. However, it provided an indication of which areas of CAA practice were relatively mature and which were not.

4.2.1 SUMMARY OF PHASE 1 SCOPING SURVEY FINDINGS

An analysis of the phase 1 scoping survey can be found in Appendix A. This showed practice, even in institutions that were explicitly supportive of CAA, to be emergent at best. CAA appeared to be in a weak position to drive innovation in learning and teaching. CAA processes were not well established. It was perceived neither as an institutional driver for L&T nor embedded within the culture. Whilst centrally funded and coordinated initiatives were common, academic departments had done little to develop their own local plans for implementing CAA. There was little targeted support for specific academic projects.

CAA communities of practice appeared still to be based upon small cores of committed experienced CAA users and staff development appeared to be limited to bundled training in CAA roll-outs. Few academics received formal training in the construction of objective items.

There was little evidence that the surveyed institutions rewarded academics or support staff for CAA development and CAA developers appeared isolated from education departments where CAA seldom appeared in departmental RAE returns. The apparent impotence in budgetary terms of CAA steering groups, as described by the kinds of people that could be expected to comprise them, bore closer examination. Considering the relatively high incidence of well-resourced centralised CAA applications and support facilities, the question of why there was so little routine use came sharply into focus.

4.3 Phase 1 interviews

A schedule was designed to investigate the initial topics, namely the extent to which the shift to CAA-based assessment had taken place in higher education , what are the best ways to implement CAA systems in universities and what factors encourage people to use it. A topic concerning the observable characteristics of good CAA applications was added.

The length of the phase 1 interviews was around 45 minutes and the script was designed to elicit the maximum amount of information possible using a set of three key open-ended questions, one for each of the initial research topics. Each of these had associated prompts for use where respondents were not fluent. A set of in-depth probes was pre-compiled but seldom required because the respondents were fluent. Questions are shown shaded, prompts unshaded (Table 5).

1 Culture: To what extent does your institution commit real resources to CAA?	
1 (a)	What kind of commitment does your HEI have to CAA at an institutional level?
1 (b)	Infrastructure: to what extent has the institution integrated CAA into its practice?
1 (c)	Tell me about your HEI's CAA procedures?
1 (d)	If they exist, what relation do they have with the University's exam procedures?
2 Expertise: What CAA skills and experience do the institution's staff and students have?	
2 (a)	Tell me about the kind of testing you do?
2 (b)	How long do people take to get familiar with the system?
3 Targets: What distinguishes good CAA applications from poor ones?	
3 (a)	What are the pitfalls to watch for when implementing CAA?
3 (b)	Do you have any anecdotes, or interesting experiences with CAA?

Table 5- summarised phase 1 interview schedule

The questions were not always asked in the same order depending on the dynamics of each interview. In some cases not all the questions were asked either because respondents gave the information unprompted or because time ran out. Respondents often volunteered information that was relevant and interesting but unanticipated in the script. Where time allowed these leads were followed according to the principle of allowing new concepts to emerge naturally from the data (Glaser and Strauss, 1967; Strauss and Corbin, 1990; Strauss and Corbin, 1998a).

4.4 Phase 1 Data Analysis

Open coding, particularly in the first phase of data analysis, was found to be 'mechanical' in nature, in contrast to axial coding which was experienced as a more 'creative' process. Theory building began using Strauss and Corbin's mini-framework and paradigm during axial coding and continued with selective coding. The open coding process is important because it provides a substrate of categories which feed into axial coding. A detailed account is given here with the aim of illustrating the procedure used throughout the study. The open coding process of subsequent phases in the next two chapters is described in less detail.

4.4.1 PHASE 1 OPEN CODING

This section depicts the open coding performed during the first phase of GT analysis. The derivation of categories and their properties and dimensions is recounted. The next section describes the phase 1 axial coding process.

The initial broad categories for the first data analysis phase were populated from two recent national CAA surveys (Bull et al., 1999; Stephens and Mascia, 1997). These were augmented by an initial survey of eight learning technologists and six semi-structured interviews with learning technologists. The interview data provided a rich source of new concepts and it is these which furnished the categories described below. Memos were recorded throughout the coding process as a way of fixing impressions of what was 'going on' (p. 110). Before each category was labelled, the researcher tried to stand back and ask 'what is going on here? And does what I see fit the reality of the data?' (p. 45).

The first step in open coding is *conceptualising* where concepts in the data are identified and labelled according to context. Where appropriate, labels are named directly from phrases used by respondents. This *in vivo* style of coding is commended as a way to facilitate authenticity in labelling: '… the conceptual name or label should be suggested by the context in which an event is located' (1998a p. 106).

Nearly 200 concepts were discovered during the first open coding passes. The number of new concepts decreased throughout the sequence of six interviews, which was due largely to the re-use of concepts that had been discovered earlier in the analysis. Several additional coding passes were made with the aim of identifying concepts which were similar enough to be condensed into one which had greater 'explanatory power'. This operation was performed with some care to avoid the possibility of confusing similar sounding concepts that were actually quite distinct. Separate backups were made of the node scheme beforehand because Nvivo has no 'undo' function'. At this early stage in the analysis I prized detail above elegance and as a result, the coding scheme quickly became dense and unwieldy. Arranging the categories hierarchically made the top-level categories manageable.

The next stage was categorising, in which the concepts were arranged according to whether they were categories, properties of categories, or dimensions of properties.

4.4.2 CATEGORISING THE PHASE 1 DATA

According to Strauss and Corbin, categories are abstractions from the data used to classify concepts (pp. 113-114). Once categories have been identified, three kinds of finer distinction can be made. The *properties* of a category are attributes which can be used to describe it in detail. The *dimensions* of a category are attributes which measure it. The *subcategories* of a category are finer divisions of categories that typically take into account how, when and why phenomena occur (pp. 116-119). The following convention is adopted here to clarify the narrative:

- Categories and sub-categories are in **bold**
- Properties are in *italics*
- Dimensions are in <u>underlined text</u> (with the range shown in brackets).

For example, **uptake of CAA** is a top-level category which has **obstacles** as one sub-category and **drivers** as another: a property of **drivers** is *institutional commitment* of which a dimension is <u>degree of commitment</u> which has a range of (full to partial).

QSR's *Nvivo™* qualitative data analysis (QDA) package was used to formalise the re-arrangement of concepts discovered in the conceptualising stage into categories, subcategories, properties and dimensions. Two hundred concepts were originally coded as non-hierarchical 'free' nodes and were then reorganised into hierarchical 'trees' according to whether they appeared to be central categories or subcategories.

Similar concepts were collected into initial categories. At this stage it became clear that according to the number of times cited, some factors were of greater significance to respondents than others. For example, more than half of all the utterances recorded in the phase 1 interviews referred to just two categories, namely the conditions influencing the **uptake of CAA** and **CAA system implementation**. Learning technologists often pulled the conversation around from other topics to focus on these.

The open coding scheme was tabulated according to the six main categories that emerged during this phase of coding. The major categories which emerged from the phase 1 data are summarised with the total number of utterances coded for each and are arranged in order of the total number of utterances coded for each (Table 6).

Raw category	Number of utterances coded
1. Uptake of CAA	58
2. System implementation	52
3. Outcomes	26
4. Assessment system issues	25
5. Assessment application type	25
6. Stakeholder attributes	23
Totals:	*209*

Table 6- Major raw categories discovered in phase 1 open coding

Taking these categories in order, **uptake of CAA** is a set of factors which directly influence tutors' decisions about using CAA. **System implementation** refers to the characteristics of CAA infrastructures and is concerned with the ways in which systems are realised in institutions. The **outcomes** of CAA applications may be favourable or otherwise. **Assessment system issues** concern intrinsic attributes of CAA systems and the kinds of choices made when selecting or implementing them. **Assessment application type** refers to attributes of assessment activities such as how much is at stake and whether an aim is to enhance student learning. **Stakeholder attributes** concern the propensities and experiences of tutors and other participants in CAA activities.

4.4.3 DEVELOPING PROPERTIES AND DIMENSIONS

The categories were arranged under major top level headings according to whether they were properties, dimensions or subcategories of the top-level categories.

> The 'constant comparative' aspect of producing a grounded theory (Glaser and Strauss, 1967) came into focus as the need to constantly refer between categorisations and data became more evident. This in turn informed the researcher's emergent understanding of how all the concepts were interrelated at a more abstract level: these impressions were captured in memos which were recorded during the analysis. Where insufficient information was provided by existing memos and coded nodes, the interview transcripts were consulted and where necessary re-coded and re-annotated (Strauss and Corbin, 1998a p. 109).

One example of the interplay of categorised data and analysis that resulted in the re-categorisation of some concepts was general 'naivety about all the variables' and 'very good understanding of CAA issues' which were interpreted as opposite poles of the same concept. Some concepts were readily categorised as dimensions of other properties; for example, 'extent to which courses use formative quizzes' is one possible dimension of 'used as a learning tool'.

Conversely, it was obvious that although some concepts were superficially similar, they were actually different in type. For instance, **pressure for more productivity** and **perception that CAA is cost efficient** appeared at first sight to have similar meanings, but revealed differences in closes examination. The first appears to be a causal condition in Strauss and Corbin's terms, whilst the other is actually more like an action or interaction of individuals in their terms.

4.5 The phase 1 open coding scheme

A description of the 'properties and dimensions' scheme is provided in this section as a 'snapshot' of the open coding analysis as it stood at the end of the Phase 1 open coding process. It is provided as an illustration of the extent and complexity of the initial coding scheme and because much of the scheme is derived directly from ‘in vivo’ codes named from actual utterances in interview transcripts or from concepts described in earlier surveys, much of it could be regarded as self-explanatory. For this reason the categories, sub-categories, properties and dimensions are presented here ‘as is’ with little in the way of citations from the data. However, the axial and selective coding operations that follow are so illustrated because they are rather more abstract.

4.5.1 RAW CATEGORY 1: OBSTACLES AND DRIVERS

The category which coded the greatest number of passages in the phase 1 data was **uptake of CAA** which had the subcategories **obstacles to uptake** and **drivers for uptake**. A numerical breakdown of how the number of utterances coded by each concept varied has been given for **uptake of CAA (obstacles and drivers** to illustrate the accounting procedure used to estimate relative importance (Table 7). The open coding analysis for the sub-category **obstacles to the uptake of CAA** is also summarised below (Table 8) and the properties are loosely arranged in a sequence with top-down elements at the top of the table through infrastructural elements down to the behaviour of individual tutors at the foot of the table.

1.a Uptake of CAA (Obstacles)		
Sub-category	**Property**	**Dimension (range)**
Obstacles to uptake of CAA (22)	Authored items (2)	Quality of items (high/low) (2)
	CAA system problems (4)	Hardware platform robustness (good/poor) (1)
		Network reliability (good/poor) (1)
		Software resilience (good/poor) (1)
		Vendor support (good/poor) (1)
	Lack of time (9)	Availability of people with time to innovate (good/poor) (1)
		Tension between productivity & better learning (high/low) (1)
		Time to learn CAA tools (sufficient/insufficient) (5)
		Time to check assessments (sufficient/ insufficient) (2)
	Tutors scared (3)	Perception of riskiness (high/low) (2)
		Tutor risk propensity (high/low) (1)
	Tutor naivety (2)	Naivety about all the variables (high/low) (1)
		Pedagogical naivety (high/low) (1)
	Lack of institutional commitment (2)	Degree of commitment (full/partial) (2)
Note: number of utterances in phase 1 interviews coded shown in brackets		

Table 7- Raw category 1: Uptake of CAA (obstacles)

Properties of **obstacles to CAA uptake** which emerged from the analysis of phase 1 interview data revealed a rich variety of factors which were mostly artefacts of tutor behaviour. The property *authored items* had a metric of item quality with a range varying between well-written to poorly-written which fuelled fears of ‘dumbing down’ among their peers. This was also seen as a threat to CAA uptake by learning technologists who were fearful of attacks from senior management and quality assurance managers based on a perceived lack of academic rigour: as one said ‘QA people look at what some [tutors] produce and conclude that CAA can’t do higher order outcomes’ (Learning technologist LtO2M001).

A second aspect of **obstacles** was *CAA system problems* with four dimensions namely hardware platform robustness, network reliability which emerged as a maturing factor that now caused relatively few problems compared to the performance of older 'thinwire' Ethernets, software resilience and vendor support which varied in both coverage and quality.

The third kind of **obstacle** was *lack of time* with four dimensions. The first was availability of people with time to innovate which varied according to the magnitude of competing pressures on tutors. The second was the resulting tension between productivity and better learning which emerged as an artefact of time pressures on tutors who sometimes pursued a 'bulk' approach to item generation in preference to more sophisticated strategies that produced smaller numbers of 'higher level' (as in Bloom's taxonomy) items. The third metric was the extent to which tutors had time to learn CAA tools which was varied from 'barely enough' in the best cases to none. A closely related metric was *time available to check assessments*. No tutors had more than an 'adequate' amount of time to learn how to use CAA tools. *Tutor naivety* was a property of **obstacles** with two dimensions: a general naivety about all the variables and a more specific *pedagogical naivety* (high/ /low). Tutors perceptions of risk and their risk propensity were dimensions of the **obstacle** property *tutor scared* of CAA going wrong. The last property of *obstacles* was *institutional commitment* with a dimension of degree.

The other sub-category of **uptake** which emerged was **drivers for the uptake of CAA** (Table 8). These were tabulated with 'top-down' factors at the top of the table preceding 'bottom-up' factors and factors that concern the behaviour of individual tutors at the foot.

1.b Uptake of CAA (Drivers)		
Sub-category	**Property**	**Dimension (range)**
Drivers for uptake of CAA (36)	Direction of impetus (2)	Direction (top down/bottom up) (2)
	Commitment (7)	Position in institution (organisational/operational) (1)
		Level of commitment (full/partial) (2)
		Resourcing for CAA development (full/partial) (2)
		Support for central system (full/partial) (2)
	Pressure for more testing (2)	Magnitude of pressure (high/low) (2)
	Productivity pressures (2)	Magnitude of pressure (high/low) (2)
	Economies of scale (1)	Department size (large/small) (1)
		Student cohort size (large/small) (1)
	CAA system support (3)	Effectiveness of peer support (full/partial) (1)
		Range of internal support (full/partial) (1)
		Effectiveness of vendor support (fully/partial) (1)
	Policy & procedures (3)	Awareness of procedures (full/partial) (3)
	Support requirements (4)	Tutors' item-writing skill (comprehensive/partial) (1)
		Tutors manage themselves (completely/partially) (1)
		Tutors' web skills (comprehensive/partial) (1)
		Students' web skills (comprehensive /partial) (1)
	Good links between CAA team & tutors (2)	CAA fora include tutors (fully/partially) (1)
		Tutors encouraged (fully/partially) (1)
	Tutors perception of 'Fitness for purpose' (4)	Application (sophisticated/utilitarian) (1)
		Demonstrability of learning improvements (full/partial) (1)
		Formative use (frequent/none) (1)
		Courses are IT-based (fully/partially) (1)
	Availability of staff with ideas (1)	Tutors (willing/unwilling) to ask about CAA (1)
	CAA community grows by word of mouth (3)	Positive stories heard (completely/partially) (2)
		Degree of CAA uptake: (full/partial) (1)
	CAA easily sold to tutors (1)	Benefits tutor directly (fully/partially) (1)
	Risks managed (2)	Effectiveness (full/partial) (1)
		Anticipated (fully/partially) (1)
Note: number of utterances in phase 1 interviews coded shown in brackets		

Table 8- Raw category 1: Uptake of CAA (drivers)

The first aspect of **drivers** is the *direction* of impetus which has the metric <u>direction</u>. Some drivers emerged from the data as (top down) corporate fiats (an authoritative sanction, an authorization' - OED), whilst others appeared from the opposite direction as the 'grass roots' pressure of individual tutors wanting to extend their practice. Organisational properties of drivers include *commitment* in terms of <u>position</u> within institution (management/infrastructure/tutors), <u>level of commitment</u>, <u>resources for development</u> of CAA and <u>support for central CAA system</u>. Both *pressure for more testing* and *pressure for more productivity* appeared to act at the organisational level and share the dimension of <u>magnitude</u>. A property related to productivity pressures was *economies of scale* which had dimensions of <u>department size</u> and <u>student cohort size</u>. *Economies of scale* emerged from <u>department size</u> according to whether several tutors in the same group were sharing expertise or whether one or two isolated individual tutors were using CAA tools. The <u>student cohort size</u> varied from large intakes where tutors struggled to find enough time to mark high volumes of traditional assessment materials to small groups where economies of scale were less obvious.

An intermediate level between the institution and the individual tutor contains a set of drivers characterised as 'infrastructural', shown between bold lines (Table 8). The first of these is *CAA system support* with three dimensions. Peer support is the degree to which technical support is available from peer organisations such as other universities. The other two dimensions were associated with the range of expertise available to support CAA. The first of these was range of internal support which varied from centrally-funded comprehensive technical support structures to ad hoc arrangements made by individual tutors. The second was effectiveness of vendor support which varied from well-resourced and responsive technical support structures to vendors perceived as rendering an inadequate service giving inaccurate information or which were difficult to contact.

Another set of four properties of uptake emerged which characterised the nature of support given to tutors who wanted to use CAA. The first of these was the existence of effective CAA *policies and procedures*, a dimension of which was the degree that tutors had awareness of procedures which varied from being pervasive in institutions where policies and procedures were considered by respondents to be well established through to erratic in institutions where such documents had not been long established or were said to be inadequate. A second property of uptake at this level was the *support requirements* of tutors with four dimensions, two of which were tutors' item writing skill and how well tutors manage themselves - the level of their dependence on support staff - which ranged from 'independent' to 'completely reliant'. The other two dimensions were tutors' web skill rated by learning technologists as 'mature' (comprehensive) at one extreme and 'inadequate' (partial) at the other and student web skill which ranged from 'excellent' to 'inadequate'. Thirdly, *good links* between CAA team & tutors emerged from descriptions by learning technologists with two metrics namely the extent to which CAA fora include tutors which ranged from 'well attended' to unattended and how effectively tutors were encouraged to use CAA by learning technologists.

A further set of five properties of drivers emerged which were concerned more or less directly with tutors' behaviour and these are shown below the second bold line (Table 8). To begin with *tutors' perceptions of fitness for purpose* had four metrics. The first was application sophistication which means how tutors implement CAA - as a teaching tool through to use as a productivity aid and at the other extreme a requirement. The second metric was demonstrability of learning improvements which ranged from 'easily shown' (full) in one case to 'unproven' (partial) in another and the third was the degree of formative use which varied from 'heavy' to 'never used' . The remaining metric of these perceptions was the extent to which courses are IT-based where students expect assessment to be delivered electronically when all other course materials are also offered electronically compared to courses which are principally paper-based. The second tutor-oriented property of drivers was *availability of staff* *with ideas* with the metric tutors' willingness ask about CAA which varied according to how open to innovation tutors were. The third property concerned the tendency of CAA uptake to *grow by word of mouth* which emerged as the principle mode by which diffusion of this innovation proceeds. Its first dimension is the extent to which stories are heard by peers who may be considering CAA which varied from 'rave reviews' (sic) to 'horror stories' (sic) when a large summative CAA exercise went wrong. The second dimension is the degree of existing uptake which could be seen as a crude measure of how likely non-users are to become users as uptake approaches saturation rather than the isolated small-scale practice seen at the beginning of uptake. The fourth property of uptake concerning tutors was CAA being *easily sold to tutors* which was measurable in the degree to which it was seen to benefit the tutor directly. In one case a learning technologist cited tutor resistance to VLE uptake on the grounds of low productivity benefits, but noted that CAA might be seen as a productivity tool by the same tutors.

The fifth tutor-oriented driver was management of risk which emerged as a key factor in driving or restricting CAA uptake and was measurable by two metrics. These were the relative effectiveness of risk management measures which was said by learning technologists to vary from 'well contained' to 'non-existent' and the degree to which risks are anticipated by tutors which ranged from 'well prepared' to 'oblivious'.

4.5.2 RAW CATEGORY 2: SYSTEM IMPLEMENTATION

The second of the top level core categories is **CAA system implementation** which has four sub-categories associated with it, namely the **policies and procedures** that are set up within the institution to regulate the use of assessment tools generally and CAA in particular, **training tutors**, **centralising CAA** and **resourcing** (Note: the number of utterances coded in phase 1 interviews is shown in brackets- Table 9).

2. System implementation		
Sub-category	**Property**	**Dimension (range)**
Institutional policies and procedures (22)	Effectiveness (3)	Comprehensiveness (complete/partial) (1)
		Publicised (fully/partially) (2)
	Guard tutors against themselves (3)	Proof-reading (timely/last minute) (1)
		Restrict no. of gatekeepers (yes/no) (1)
		Degree of testing (full/partial) (1)
	Gatekeeper's roles (5)	Checklist scrutiny (yes/no) (2)
		Item scrutinised (fully/partially) (1)
		Schedule groups for tests (yes/no) (2)
	Suitablility of workstation rooms (4)	Preparedness level (full/partial) (2)
		Effectiveness of room booking (full/partial) (1)
		Control over workstation build (complete/partial) (1)
	Pilot tests before delivery (2)	Extent of piloting (full/partial) (2)
	External examiners see tests (1)	
	Aligned with other modes (1)	
	Tutors' roles (3)	Subject specialist item review (full/partial) (2)
		Comply with policies & procedures (fully/partially) (1)
Training Tutors (12)	Goes stale before use (3)	Goes stale before use (timely/mis-timed) (3)
	System specific (4)	Use of particular system (one/multiple) (4)
	Pedagogic (2)	Training to write objective items (full/partial) (2)
	Seen as essential (3)	
Centralising CAA (10)	Risk analysis (1)	Effectiveness (full/partial) (1)
	Bad track records (1)	
	Academic support (1)	Degree of support for centralisation (full/none) (1)
	Scalability (2)	Extent of system tuning (full/partial) (1)
		Difficulties solved by funding (fully/partially) (1)
	Security (3)	Protected from unauthorised users (fully/partially) (1)
		Protected from participants (fully/partially) (2)
	MLE Integration (2)	Managed from the VLE (fully/partially) (1)
		Utility (full/partial) (1)
Resourcing (8)	Project size (1)	
	Investment before benefit (1)	
	Central funding (2)	Centrally funded (completely/partially) (2)
	Workstation provision (3)	Room size (large/small) (1)
		Schedule w/s rooms in shifts (full/partial) (1)
		Schedule w/s rooms on multiple sites (full/partial) (1)
	Staff secondment scheme (1)	Scalable (completely/partially) (1)
Note: number of utterances in phase 1 interviews coded shown in brackets		

Table 9- Raw Category 2: System implementation (phase 1 open coding)

The subcategory **institutional policy and procedures** had eight cited properties which are listed in order according to global attributes (such as effectiveness), whether they appeared to be centralising functions and the behaviour of individual tutors.

One global attribute of **institutional policy and procedures** was their perceived *effectiveness* in terms of comprehensiveness and whether they had been publicised so that all members of the CAA community were sufficiently aware of them as 'rules of engagement' or not. The other was the extent to which policies and procedures *guard tutors against themselves*: this emerged with three dimensions namely the extent to which tutors leave proof-reading to the last minute, whether or not a decision has been taken to restrict the number of gatekeepers and the degree or thoroughness of pre-delivery QA testing.

The centralising aspects of **institutional policies and procedures** included *gatekeeper's roles* which had the dimensions of whether there is any checklist scrutiny, whether there is any item scrutiny, for instance to detect typographic errors and whether or not the gatekeeper's functions include scheduling groups for tests. The other centralising property of **policies and procedures** was *suitability of workstation rooms* which emerged with the dimensions of workstation preparedness level, effectiveness of room booking system and the ability of CAA administrators and learning technologists to maintain some level of control over workstation build in order to minimise any disruption due to unwanted interactions between software components.

Three properties bridged centralising functions described above and functions which were more the domain of tutors. Of pivotal significance was the extent to which tutors *pilot tests before delivery* which had the dimension extent of piloting that varied from always to never: in some institutions this is done by CAA gatekeepers, in other it is always the responsibility of tutors. Whether an *external examiner sees CAA tests* or not emerged as dependent on the weighting of tests: learning technologists saw this as a measure of how seriously CAA testing was taken. This was regulated through central policies and procedures in some institutions and in others was more of a casual arrangement between tutors and external examiners. The third property was whether CAA is *aligned with other modes* of assessment such as essays or portfolios.

Aspects of the sub-category **policy and procedures** concerning tutors included procedures regarding *tutors' roles*, which had dimensions of whether or not subject specialists review items and the extent to which tutors comply with policies and procedures (related to the effectiveness of policies and procedures described earlier).

The next subcategory of **system implementation** is **training tutors**. The first property was of this was the timeliness of training which *goes stale before use*, which varied from flexible 'just-in-time' delivery to less tractable fixed schedules. The second was training being focussed on *use of a particular system*. The third was whether training included help to *write objective items* and a fourth was whether training was *seen as essential* by stakeholders.

Centralising CAA is a sub-category of **policies and procedures** with three dimensions of its own and three properties, each with their own dimensions. The properties of *centralising CAA* were the effectiveness of *risk analyses* performed, whether or not an *early attempt to centralise CAA failed* (said to be a significant brake on centralised uptake) and the *degree of central academic support for CAA*. In addition there were two properties associated with specific CAA systems. *Scalability* had dimensions of *extent of system tuning* required to make a centralised

CAA system effective and the extent to which difficulties were *solved by funding* which varied from 'we threw money at the problem' (Learning technologist LtO5M001) at one extreme to an absence of secure funding at the other. *Security* emerged with dimensions of the extent to which CAA systems are *protected from unauthorised users* and the extent to which they are *protected from participant* interference. The third system-specific property of **centralising CAA** was *MLE integration* with dimensions of the ease with which CAA can be managed from the VLE and how perceptions of MLE *utility* vary from the view that they are 'trendy' ways to spend money through to opinions that they provide real benefits.

The final sub-category of **policies and procedures** is **resourcing** with five properties. The first is *project size* which influenced the quality of support for CAA (large projects subsidised ICT support for CAA). The second was whether any *investment before benefits* existed (seen as a metric of institutional commitment. The third property was the degree to which CAA was *centrally funded* which was also an indicator of institutional commitment. Concerns held by learning technologists regarding *workstation provision* revolved around room size, the degree to which flexibility of scheduling workstation rooms in shifts is possible and the degree of any flexibility in scheduling workstation rooms on multiple sites. The last property of **resourcing** was the provision of any *staff secondment scheme* that made it possible for internal learning technology staff to be 'contracted out' to academic departments for specific CAA projects. Related to this was the extent to which any *secondment model* was found to be scalable: often these arrangements had been set up for small-scale pilot projects and could not supply higher levels of support for major projects.

4.5.3 RAW CATEGORY 3: OUTCOMES

Apart from success, the **outcomes** of CAA applications include failure. The phase 1 respondents took successful outcomes for granted and ignored questions about what went well, but were in some cases eloquent about causes of failure. Sub-categories associated with failure are **causes of technical] failure**, the **failure type**, the long-term **consequence of failure** and implications for uptake in terms of the **public nature of failures** (Table 10).

3. Outcomes		
Sub-category	**Property**	**Dimension (range)**
Causes of failure (16)	Neglected practice tests (5)	
	Scalability issues (11)	Capacity (number of users) (8)
		Rate of uptake (new users per year) (3)
Failure type (2)	Students' answers not saved	
Consequences of failure (6)	Students forced to repeat test (3)	
	Test abandoned (2)	
	Restrict new uptake (1)	
Public nature of failures (2)	Widespread loss of confidence (2)	
Note: number of utterances in phase 1 interviews coded shown in brackets		

Table 10- Raw category 3: Outcomes

The root causes of problems were identified as procedural and technical. One of the two properties categorised under *causes of failure* was *tutor neglects practice tests* which refers to the risks inherent in delivering high-stakes tests without giving the candidates practice in using the system first. Where CAA systems were found to be load sensitive, the possibility existed of *scalability issues* which were largely precipitated by high rates of uptake. The two dimensions of this were <u>capacity</u> (number of simultaneous users) and the <u>rate of uptake</u> in terms of new users gained per year.

The only failure type identified in the data was *students' answers not saved* although others are known in the literature including logical errors in assessment construction and typographical errors. The consequences of CAA failures were seen as far reaching and varied in severity from *students forced to repeat test* through to *test abandoned*. A mitigating action performed by learning technologists to limit the consequences of a CAA system that didn't scale well was to artificially *restrict new uptake* thus providing a breathing space for corrective action.

A sub-category of unfavourable outcomes was the **public nature of failures**, which involved a *widespread loss of confidence* in CAA systems. One learning technologist reported that failures of this kind had a greater impact than either email failures or computer-assisted learning (CAL) failures.

4.5.4 RAW CATEGORY 4: TYPE OF ASSESSMENT SYSTEM

The fourth category emerged as **type of assessment system**, which divides into the two sub-categories **paper-based** and **CAA systems**. The only dimension of *paper-based assessment* is its <u>vulnerability to procedural errors</u> which was also cited for CAA. The subcategory **CAA systems** had seven properties, all with dimensions (Table 11).

4. Assessment systems		
Sub-category	**Property**	**Dimension (range)**
Paper-based	Vulnerable (1)	Procedural errors (significant/not) (1)
CAA systems	Vulnerable (2)	Procedural errors (significant/not) (2)
	Assessment type (6)	Range of item use (basic MCQ/full range) (3)
		Range of application (questionnaires/formative/summative) (1)
		Stakes (high/low) (2)
	Ease of use (6)	Effort required to learn (easy/difficult) (2)
		Time to learn (hours/weeks) (1)
		Flexibility (full/partial) (1)
		Ease of authoring tool deployment (easy/difficult) (1)
		Accessibility (full/partial) (1)
	Cost of development (1)	Cost of system development (high/low) (1)
	Robustness (3)	Robustness (full/partial) (3)
	Complexity (4)	System scale (single CPU box/multiple CPUs) (1)
		Connectivity (standalone/online) (1)
		Number of item types (Many/few) (1)
		Developer administered and maintained (yes/no) (1)
	Security (2)	Test attempts controlled (fully/partially) (1)
		Exiting test is controlled (fully/partially) (1)
Note: number of utterances in phase 1 interviews coded shown in brackets		

Table 11- Raw category 4: Type of assessment system

Assessment systems were divided by respondents into the sub-categories **paper-based** and **ICT-based** (used in CAA). Little was said about **paper-based** assessments systems apart from the observation that although they are conventionally seen to be safer alternative to CAA systems, they are in practice equally *vulnerable* to procedural errors as **CAA systems**. For **CAA systems** alone, the properties which emerged from learning technologists' responses were characterised either as attributes of assessment applications- directly above the emboldened line- or as aspect's of the system's behaviour tabulated below it (Table 11).

The characteristics of *assessment type* described emerged as the range of item use (basic MCQ through to the full possible range of item types), range of application type which ranged from questionnaires through to a variety of formative to summative uses and stakes in terms of the assessment's impact on students' careers. Learning technologists referred to *ease of use* as an intrinsic property of CAA systems and mentioned four dimensions as metrics. The first of these is effort required to learn how to use CAA systems which appeared to be a measurement of how readily accessible the tools were and varied from easy through difficult. The second is the time required to become proficient with tools appeared to vary from very little (a few hours) through to an extensive period (some weeks), whilst the third was the flexibility of CAA tools which varied from general purpose tools such as *Perception*™ that could be used for almost any assessment activity through to packages which were restricted to formative quizzes. The fourth aspect of *ease of use* described by learning technologists is ease of authoring tool deployment which ranges from procedures involving little more than making a decision to use the tools because they were browser-based to desk-top installations such as *Perception*™ which made significant demands on tutors in terms of time and effort. The fifth *ease of use* facet was system accessibility varying from all participants being able to use CAA anytime anywhere to CAA systems that presented significant obstacles to some students due to limited SENDA[1] compliance.

The remaining properties were also intrinsic attributes of CAA systems. Arranged in order of citation frequency, the first of these is *cost of system development* which varied from significant where a centralised system is being integrated with an existing centralised system such as a student record system (SRS) or virtual learning environment (VLE) to less significant (low) where open-source tools were used locally by individual tutors. A fifth property of dimensions of **CAA systems** is *robustness* (including reliability) which varied from robust to (partial) vulnerable set-ups. Systems also differed in terms of total *system complexity* which had four dimensions, the first of which was system *scale,* ranging from one server through to multiple clustered application servers and dedicated database servers. The second dimension of *complexity* is <u>connectivity</u> which varied from simple, isolated non-networked (standalone) installations to full on-line connectivity. The third way in which CAA systems differed in complexity was the absolute <u>number of item types</u> supported, with basic systems offering just MCQ through to sophisticated systems offering 18 or more. The fourth way in which CAA system complexity differed was in whether or not they were <u>developer administered and maintained</u>. Where the developers of (usually small-scale) systems are also responsible for running them, they can guarantee every aspect of an assessment's performance. The remaining intrinsic property of **CAA systems** concerned *security* in terms of how effectively <u>test attempts are controlled</u> and the extent to which <u>exiting test is controlled</u>. Both of these security aspects were cited as key determinants of tutor confidence.

4.5.5 RAW CATEGORY 5: TYPE OF ASSESSMENT APPLICATION

The category *type of assessment application* refers to the characteristics of assessment practice within the institution. Five subcategories were to do with the characteristics of assessment applications and two concerned attributes of any assessment application, namely *test duration* and the assessment's *context* (Table 12).

[1] Special Educational Needs and Disability Act (2001)

5. Assessment applications		
Sub-category	**Property**	**Dimension (range)**
Summative	Piloted (4)	Formative precursors (yes/no) (4)
	Impact of scalability issues (2)	(mild/severe) (2)
	Requires expert ICT support (1)	
	The gold standard (1)	
	Tutors are keen (1)	
	Special conditions (5)	Dedicated workstation area provision (full/partial) (3)
		Degree of Invigilation (full/partial) (1)
		Extended duration (time) (1)
Formative	Done for pedagogic benefits (1)	
	Precursor of summative tests (1)	
Questionnaires	Efficiency (1)	
	Used for student feedback (1)	
Digital portfolios	(1)	
Peer assessment	(1)	
	Test duration (2)	Duration (time) (2)
	Context (3)	Paperless (fully/partially) (2)
		Range of levels tested (foundation/PGR) (1)
Note: number of utterances in phase 1 interviews coded shown in brackets		

Table 12- Raw category 5: Type of assessment application

Of five sub-categories related to **assessment applications**, the largest number of properties and dimensions related to **summative** assessments. Two dimensioned properties of these are the extent to which assessments are *piloted* before use with the dimension of whether or not *formative precursor* practices tests are delivered and the *impact of scalability issues* which vary from scarcely discernable to disastrous. A case of this happening was described where a sharp upswing in usage exceeded system capacity resulting in a high-stakes invigilated examination being abandoned. The four remaining properties of **summative** assessment applications are that they *require expert ICT support*, that they are widely regarded as *the gold standard* (if that works everything else is easy) and that, perhaps for this reason, *tutors are keen* to do summative CAA. Special conditions for **summative tests** have dimensions of the extent of <u>dedicated workstation area provision</u>, the <u>degree of invigilation</u> and whether assessments were of <u>extended duration</u>, which was cited as being typically several times longer than formative quizzes.

Other sub-categories of **assessment applications** were **non-summative** including such as formative quizzes and questionnaires. **Formative** CAA assessments had the dimensionless properties of being *done for pedagogic benefits* and that they act as *precursors for summative tests*. An identified property of CAA-delivered **questionnaires** was *efficiency*, which was rated by respondents as relatively high compared with paper-based instruments, with some respondents citing *use for student feedback* as another property of **questionnaires**. **Digital portfolios** and **peer assessment** applications were mentioned as other **assessment applications** but no properties or dimensions regarding them emerged from the phase 1 data. The remaining subcategories of **assessment applications** were *test duration* which was mentioned as having an optimum duration of 60 minutes and their *context* which ranged from 'paperless' courses which were reported to greatly sustain CAA practice through to mixed learning courses which were described as supporting CAA to a reduced degree. The potential range of levels tested emerged as a gradation from pre-level one in remedial applications through to post-graduate research students, although no respondents reported CAA use beyond level one.

4.5.6 RAW CATEGORY 6: STAKEHOLDER PROPENSITIES AND CHARACTERISTICS

The final Phase 1 category was **stakeholder attributes** which pertains to the varying perspectives and agenda of different groups of stakeholders which constitute the sub-categories listed (Table 13). The sub-category **learning technologists** had four dimensionless properties associated with attitudes and function. T**utors** had two dimensionless properties concerned with function and one experiential dimension; **novice** and **expert tutors** with their own properties and dimensions; **senior managers** had three attitudinal dimensions and one functional property and **students** had one experiential property and one dimensioned property.

6. Stakeholder attributes		
Sub-category	**Property**	**Dimension (range)**
Learning technologists (6)	Concerned with endurance (1)	
	disinterested in HEI politics (1)	
	Protect tutors from themselves (2)	
	Convert items into assessments (2)	
Tutors (6)	Develop item writing skill (1)	
	Convert items into assessments (2)	
	Self-reliant (3)	Enthusiasm (high/low) (1)
		Expertise (great/little) (1)
		Experience (great/little) (1)
Novice tutors (3)	Lack self-reliance (2)	Time required to produce a test (duration) (1)
		Degree of support required (multiple of experienced user's requirements) (1)
	Produce ambiguous items (1)	
Expert tutors (1)	Produce tests of mixed difficulty (1)	Facility (easy/difficult) (1)
Senior managers (5)	Perceptions of CAA (5)	Perceptions of importance (high/low) (2)
		Perceptions of desirability (high/low) (1)
		Risk awareness (full/partial) (1)
	CAA tool selection (1)	Choices informed (fully/partially) (1)
Students (2)	Inexperience (2)	ICT error rates (high/low) (2)
Note: number of utterances in phase 1 interviews coded shown in brackets		

Table 13- Raw category 6: Attributes of CAA Stakeholders

The **stakeholder attributes** which emerged included the attitudes of **learning technologists**, described as being *concerned with endurance* as a result of increasing pressure from the CAA-using academics community who were portrayed as *disinterested in HEI politics* because their attention is focussed on the immediate necessity of maintaining high standards in their academic practice. One functional property of **learning technologists** was to *protect tutors from themselves* by enforcing regulatory CAA policies and procedures. They also *convert items into assessments* on behalf of tutors unable or disinclined to do this for themselves.

In contrast the attention of tutors was more focussed upon the practicalities of producing functional assessments within the limited time at their disposal. **Tutors' attributes** included two functional properties: that they *develop item writing skills* as they gain experience and some tutors *convert items into quizzes* for themselves, which denotes a higher degree of *self reliance* than in tutors who do not. *Self reliance* in tutors has the three aspects of <u>enthusiasm</u> for using CAA which varies according to tutor temperament, <u>expertise</u> in the use of online assessment tools which varies from expert status to novice and <u>experience</u> with tools, varying with the time that tutors have used them.

The sub-category **novice tutors** included unskilled authors and was notable for two properties related to their inexperience. The first of these was that they were seen to make exceptional demands on support staff due to their *lack of self-reliance*. Two dimensions of this lack of self-reliance were the *time required to produce a test* - one CAA administrator found that 'first-timers take three times longer to produce tests' (LtO5M001) and the *degree of support required* which emerged as a multiple of the degree of support required by experienced users. The other property of **novice tutors** was that they produced ambiguous items. In contrast **expert tutors** were more likely to *produce mixed difficulty tests*, which had the metric of *facility* that varied from easy to difficult: this may be an artefact of greater experience with assessment procedures generally.

Senior managers' *perceptions of CAA* had three dimensions, the most significant of which was <u>perceptions of importance</u> which ranged from high to low: for instance one learning technologist stated that senior management at his university considered that 'CAA was as important as the VLE'. A related dimension was *perceptions of desirability*, some senior managers seeing CAA as a 'necessary evil', while others saw CAA as 'not a flagship technology'. Some senior management teams (SMTs) lacked *risk awareness* which made CAA project failures more likely. A related attribute of SMTs was their role in *CAA tool selection*, which often lacked discernment: one disgruntled author and administrator of a small-scale CAA tool parodied SMT attitudes saying 'If it's not expensive it's no good' (LtO3M001).

The only characteristic of **students** that emerged from the phase 1 data was *inexperience* in using CAA tools which was likely to cause the kind of ICT errors often perpetrated by novice uses of any ICT application. Examples mentioned by respondents including clicking on a 'start' button repeatedly, thereby creating multiple test sessions, or attempting to use a browser's navigation buttons instead of the built-in navigator to move between questions, thereby breaking the CAA server session.

4.6 Axial coding in phase 1

Once the open coding process had ceased to throw up new categories, sub-categories and properties, I proceeded to axial coding which is the process of relating major categories to other major categories through their subcategories (Strauss and Corbin, 1998a). To begin with, the properties and dimensions that had been discovered in the open coding phase were re-examined in terms of conditions and consequences (Strauss and Corbin, 1990 pp. 124-5). This section describes the axial coding of the phase 1 data which was performed in the manner described earlier in the methodology chapter. The next section describes phase 1 initial selective coding procedure.

4.6.1 CORE CATEGORIES IN PHASE 1

Core concepts were identified both according to the frequency with which they were cited in the data (directly or indirectly) and also by their power to explain 'what is going on'. A re-examination of the open coded data in terms of the apparent weight given by respondents showed that there were really three core concepts which emerged as central to the uptake of CAA on a large scale. These were *tutor intrinsic factors, modifying actions* taken by the institution and *likelihood of using CAA* (Table 14). This represents a raising of the level of abstraction: these categories did not exist in the original open coding scheme, but instead were the result of a higher level of analysis of the original phase 1 data. This might be expected as a normal feature of axial coding: open coding is about fracturing the data, whilst axial coding is the process of understanding how categories relate to each other. The process of identifying, labelling and arranging categories that began during initial open coding continues during axial coding (Strauss and Corbin, 1998a p. 124).

Core categories	**Minor categories**
Tutor intrinsic factors (obstacles & drivers)	Tutor propensities & characteristics
	Direct influences on tutors (obstacles & drivers)
	Type of assessment system
	Type of assessment application
Modifying actions	System implementation
	Outcomes
Likelihood of using CAA	

Table 14- Phase 1 core categories in terms of open coded categories

Conditions at the starting point of a CAA application- the 'givens' - emerged as **tutor intrinsic factors** which gathered together **propensities and characteristics** of tutors themselves with **direct influences on tutors**. This appeared to include the **type of assessment system** being used and the **type of assessment application**. These factors were naturally categorisable as either obstacles to a tutor using CAA, or as drivers for it. Another core category was **modifying actions** which combined **system implementation** as a set of mitigating measures taken by the institution in attempts to make CAA applications work as smoothly as possible and **outcomes** in terms of success or failure which indirectly affect future uptake. The third core category was **likelihood of using CAA**, which represented the balance of drivers over obstacles. Once the core concepts had been identified, they were arranged at the top of a hierarchy with a layer of related but less significant concepts beneath them. Coding density was maintained by grouping the remaining codes at lower levels still according to their relationships with these upper-level concepts. These were tabulated (Table 15) and then the relationships which emerged from axial coding were made more explicit using mini-frameworks and the paradigm model.

Core categories	Minor categories	Properties of minor categories
Tutor intrinsic factors	Direct influences on tutors	obstacles
		drivers
	Type of assessment system	Paper-based system
		CAA systems
		complexity
		Connectivity
		Choose of system
		Security
	Assessment application	Summative
		Formative
		Questionnaires
		Digital portfolios
		Peer assessment
		Test length
		Context
	Stakeholder propensities & characteristics	Learning technologists
		Tutors
		Novice tutors
		Expert tutors
		Senior managers
		Students
Modifying actions	System implementation	Policies & procedures
		Training Tutors
		Centralising CAA
		Resourcing
	Outcomes	Successful application
		Failed application
Likelihood of using CAA	Extent to which drivers outweigh obstacles	

Table 15- Core categories, minor categories and their properties (ph. 1 axial coding)

4.6.2 DESCRIBING THE PHASE 1 AXIAL CODING SCHEME

Conditions and consequences

At first it appeared that a large number of the categories classed as ‘obstacles and drivers’ related to the conditions under which CAA is implemented in universities. In the same way, another key group was classified as ‘outcomes’ and this seemed clearly to represent the consequences of actions and interactions with conditions. It seemed that the remaining categories, sub-categories, properties and dimensions could also be promptly and simply reinterpreted as actions, interactions, conditions or consequences.

Further analysis revealed a more complex picture after it became apparent that many of the concepts cited as obstacles to the uptake of CAA were really interactions between stakeholders and some conditions. For example, under the conditions that a CAA system has become overloaded, tutors' attitudes can change from neutral to antipathetic towards CAA thus inhibiting uptake on a large scale. Each of the Phase 1 categorised concepts was therefore carefully re-examined and recoded in the context of the emergent paradigm (section 3.7.2). Many of the concepts discovered in the open coding were not readily interpretable in terms of actions, reactions, conditions or consequences and it turned out that the key to making sense of them was to reach an understanding of which concepts were interactions. Once these were identified the other components fell into place around them, as in the example of the overloaded system described above. This procedure was iterative and meant revisiting the raw data, the memos and the open coding scheme several times in order to verify relationships between the concepts.

4.6.3 SIMPLIFYING THE CODING SCHEME

A few factors were found that could be clearly construed as *de facto* obstacles rather than drivers or *vice versa*. For example, the presence of technical problems is an obvious obstacle, whereas the absence of technical problems is a base expectation rather than a driver. One possible approach would have been to continue simplifying the coding scheme by consolidating some of the categories, because although there were only six main categories in the Phase 1 open coding scheme, there was a very large number of subcategories with attendant properties and dimensions (some 130 of these remained even after a substantial degree of consolidation during open coding). The detail in coding made the scheme unwieldy, but preserved richness and permitted constant comparison of coded phenomena without restricting the scope analysis. Strauss and Corbin recommend a reiterative process for open coding so that one constantly 'compare[s] incident with incident as we go along so that similar phenomena are given the same name. Otherwise, we would wind up with too many names and very confused!' (1990 p. 63). Coding trees were left 'unpruned' until the entire analysis was nearly completed, when important top-level concepts were used to construct emergent theory during selective coding.

4.6.4 THE EMERGENCE OF BIPOLAR FACTORS

It became evident that many of the individual obstacles and drivers were actually single continuous factors. For instance, 'provision of time' was always cited as a driver, whereas its inverse - lack of time - was invariably cited as a obstacle. Therefore 'provision of time' can be seen as a 'bipolar' variable, its presence or absence being an active driver or obstacle accordingly. The emergence of bipolar factors made simplified explanations possible and facilitated a more elegant presentation of the interplay between key factors.

4.7 The paradigm model

Strauss and Corbin describe the axial coding process as 'looking for cues in the data that denote how major categories might relate to each other' (Strauss and Corbin, 1998a pp. 126-127). One tool for doing this is the paradigm model whereby a broad distinction is drawn between the *structure* of a phenomenon in terms of underlying contextual framework (conditions) and *process* in terms of the way people handle conditions, namely actions/interactions and consequences (Table 16).

The paradigm model						
	STRUCTURE				**PROCESS**	
Component	**Causal conditions**	**Phenomenon under study**	**Context**	**Intervening conditions**	**Actions/ Interactions**	**Consequences**
Description	Causes for the studied phenomenon	A category, usually a main theme of the research	Circumstances that underlie the studied phenomenon	Things that change the studied phenomenon	How people handle the conditions - top-down or routine responses	Outcomes of actions and interactions - may be intentional or otherwise
Questions to ask	Why? Where? When?				Whom? How?	What happened?

Table 16- Strauss and Corbin's (1990, 1998) paradigm model

Strauss and Corbin encourage GT analysts to seek 'explanations rather than rigidly code according to these abstract headings' (p. 129). They also advise analysts to treat discovered relationships with caution: 'It must of course be borne in mind at all times that the paradigm does not necessarily describe causal relationships' (p. 130). The open codes discovered earlier were analysed in terms of conditions, actions, interactions and consequences. Two phenomena emerged during axial coding as core categories about which other categories were naturally arranged, namely *tutors' decision-making about using CAA* and *risk mitigation measures*.

4.7.1 TUTORS' DECISION-MAKING ABOUT WHETHER TO USE CAA

Having chosen the phenomenon of *tutor's decisions to use CAA* for assessment applications as a central category, other categories were arranged according to the paradigm model.

The phenomenon of tutors' decision-making about the use of CAA

A central phenomenon is *tutors' decision-making* based on whether obstacles are overcome by a net balance of drivers in favour of using CAA (Table 17).

Phenomenon	Why?	Where?	When?
Tutors decision-making	Drivers outweigh obstacles	Academic departments	During & after decision to use CAA

Table 17- The phenomenon of tutors' decision to use CAA (ph. I axial coding)

This decision-making process was established in academic departments, which is natural since that is where most academics are based. However, there is a wide range of obstacles and drivers which directly or indirectly influence this decision-making process. These are described as causal conditions and context in following sections. A consequence of tutors deciding to use CAA is that others may follow their example.

Causal conditions associated with tutors' decisions to use CAA

Causal conditions could be described as initiating inputs or drivers and may be external or internal in origin. Two causal conditions associated with tutors' decision to use CAA in assessment activities which were identified in the phase 1 data were *top-down resourcing* and *top-down productivity pressures* (Table 18).

Causal Conditions	Why?	Where?	When?
Top-down management pressure	Pressure for more productivity Pressure for more feedback	Top-down management	Tutors have to provide more feedback but are not given extra time to do it Competing pressures for research output

Table 18- Causal conditions associated with tutors' CAA decisions (ph. I axial coding)

Pressures for more feedback to students and for greater research productivity are seen to come via management as top-down demands. These pressures are generally perceived as drivers for the uptake of CAA because tutors are not usually given extra time to develop, distribute and mark the additional assessment load: on the contrary the demands of teaching quality assessments (TQA) and the research assessment exercise (RAE) tend to reduce the time available for assessment activities.

Contextual influences directly associated with tutors' decisions to use CAA

Contextual influences that act as obstacles or drivers exist at either operational or top-down levels, giving four basic kinds of influences (Table 19).

Level	Drivers	Obstacles
Top-down level	Top-down drivers	Top-down obstacles
Operational level	Operational drivers	Operational obstacles

Table 19- Drivers and obstacles at organisational and operational levels (ph. I axial coding)

A number of these factors are interpretable as basic conditions that could be common to anyone working as a tutor in higher education (Table 20). These factors were labelled as 'intrinsic conditions' because they appear to be natural properties of people and organisations.

Context	Why?	Where?	When?
Intrinsic organisational obstacles	Concerns about: -Fitness for purpose (Security, Expense, Scalability) -CAA is complex & ill-understood	Management Academic departments	While deciding whether to use CAA
	Tutor attitutudes -technophobia -conservatism -naïveté (don't plan ahead, lack self-reliance) -perceptions of CAA as immature technology	Academic departments	
	Tutor behaviours -novices monopolise support resources -tension between productivity & better learning	Academic departments	When preparing CAA tests
Intrinsic organisational drivers	System widely-used	Academic departments	While deciding whether to use CAA
	Tutor perceptions -see CAA as productivity aid -see CAA as learning tool -time pressures -benefits go directly to tutor -commitment to learning and teaching	Academic departments	Before & after decision to use CAA
	Tutor behaviours -have good item-writing skills -use formative testing -write ITC-based courses -committed to learning and teaching -are ICT literate	Academic departments	Before & after decision to use CAA
Intrinsic operational obstacles	Direct experience and rumours of technical issues with CAA systems	Academic departments	Before & after decision to use CAA
	Time pressures -shortage of time to learn anything new -forget how to use system before they need it	Academic departments	Constantly
Intrinsic operational drivers	CAA system operationally fit for purpose (easy to use, secure, preserves investments in item banks)	Academic departments	Before & after decision to use CAA
	CAA infrastructure operationally fit for purpose- -workstation areas: adequate performance, adequate ergonomic features, -effectiveness of room booking system, workstation preparedness -network capacity & resilience	Academic departments	Before & after decision to use CAA

Table 20- Contextual influences on tutors' decision-making (ph. I axial coding)

Intrinsic organisational obstacles appeared to be of three kinds: concerns shared by management and academics, tutor attitudes such as conservatism and tutor behaviours such as forgetting how to use CAA tools before getting to use them. The concerns of management included doubts about the fitness of CAA for the declared purpose in terms of the security of questions and marks, the expense of implementing it centrally and perceived difficulties in making it scalable. Tutor attitudes were said to include fear of technology as a threat to assessment, inherent conservatism, naivety (particularly regarding the ease with which CAA can be used) and perceptions of CAA as an immature technology. Both of these organisational obstacles were significant where a decision was made about whether or not to use CAA for an assessment activity. The third of these obstacle applies more to the period when tests are being prepared and is due to tutor behaviours that include novice users monopolising the time of CAA staff and an apparent tension between the need to improve research output whilst also improving teaching and learning performance, there being a perception that tutors can only do one or the other well.

Intrinsic Organisational Drivers can be seen as symmetrical counterpoints to the obstacles described above and were of three kinds; peer incentives, the perceptions of tutors and tutor behaviours. The fact that many tutors will consider using CAA themselves only when it has become more widely adopted stems from tutors' natural aversion to be the first to try something new, particularly where a significant degree of risk accrues and there are still other ways (that is, existing traditional ways) to perform assessment tasks. Some tutors' perceptions of CAA could be characterised as intrinsically more positive than others' regarding the productivity and pedagogic benefits of using CAA. Tutor behaviours that encouraged the adoption of CAA were mainly associated with the pursuit and possession of good ICT and assessment skills, particularly how to write good objective items. Tutors who taught on courses that already had a strong ICT component were likely to use CAA because to do otherwise would entail going back to paper for arguably the most critical part of the course. Both these perceptions and behaviours appeared to affect tutors decisions to use CAA both before and after first use. It was unclear whether tutors themselves were polarised in this regard with either a set of favourable perceptions and behaviours or a completely antipathetic set. Respondents identified tutor characteristics that encouraged the use of CAA more than those which inhibited it.

Intrinsic Operational Obstacles were identified as factors which clearly originated in the physical world and which tended to suppress uptake by discouraging tutors. The two obstacles identified in the phase 1 data both concerned tutors directly and consisted of technical issues related to the use of CAA systems and time pressures on tutors. Technical problems with CAA systems operated either directly on CAA-using tutors or indirectly as rumours on potential users and other CAA users. Time pressures provide a constant backdrop against which tutors are said to find it a struggle to learn anything new, including a new set of skills for using CAA. These pressures seem to be exacerbated by the problem of traditional instructor-led training being forgotten by the time tutors get round to using CAA tools for themselves.

Intrinsic Operational Drivers emerged as attributes of CAA systems and the ICT infrastructures that support them. They originated in support departments and could be seen as natural counterpoints to operational obstacles (Table 20). Both could be characterised as 'fitness for purpose': a distinction emerged between the suitability of CAA systems in terms of ease of use, security and how well they supported item banks which was different from the suitability pf the ICT infrastructure in terms of workstation area capability, the effectiveness of the room booking system and the capacity of the data network. Although these context factors had their origins in work done by support departments, the locus of influence was tutors working in academic departments. The time during which they operated was both before and after decisions were made to use CAA. Both factors operated to increase the commitment of existing CAA users and to increase the likelihood of non-users becoming users.

Consequences of tutors' decisions to use CAA

Increased uptake encourages other tutors to use CAA because potential users think that if it works for their colleagues, they are taking few risks in taking it on themselves (Table 21). This creates a positive feedback loop: 'nothing succeeds like success'.

Consequence	What happened?
Increased uptake encourages other tutors to use CAA	Successful systems attract users by word of mouth

Table 21- Increased uptake increases uptake (ph. I axial coding)

Unlike negative feedback loops, positive feedback loops are not self-limiting. They do however have limiting conditions (see for example Bertalanffy, 1968) and some of those obtaining in the uptake of CAA will be examined later in this chapter. Senge mentions the management of such feedback loops as an important element of the 'fifth discipline' which he also refers to as 'the cornerstone of the learning organisation' (Senge, 1990 p. 55).

4.7.2 MITIGATING RISKS OF CAA UPTAKE

Causal conditions associated with mitigating risks of CAA uptake

Three causal conditions were identified with resourcing issues that seemed to operate more or less independently as causal conditions acting in mitigation of perceived risk: provision of time, long term commitment and investing before benefits seen. All three were to some extent in the gift of management, but all appeared to operate at the level of individual tutors working in academic departments (Table 22).

Causal Conditions	Why?	Where?	When?
Provision of time	Learn CAA tools Learn objective item use	Management Academic departments	Before use of tools
	Develop & QA CAA tests	Support departments Academic departments	Before tests published
Long-term commitment	Demonstrate authenticity	Management Academic departments	Before & after decision to use CAA
Investment before benefits	Demonstrate authenticity	Management Academic departments	Before CAA productivity benefits demonstrated

Table 22- Causal conditions in risk mitigation (ph. I axial coding)

Management makes **provision of time** in order to allow tutors the time needed both to learn how to use CAA tools effectively and to learn how to use objective testing techniques before they got to grips with the tools.

Long-term commitment to the use of CAA on the part of management was significant because it demonstrated the authenticity of management's intention to support tutors who used CAA in the long term and operated both before any decision was made to use CAA and afterwards as a way of encouraging tutors to preserve their existing investment in the technology. **Investment before benefits** seems to be a pragmatic response by management to the fact that CAA productivity benefits are quite difficult to demonstrate. It demonstrates commitment to academics working in academic departments in the most tangible terms possible, namely the provision of financial support.

Intervening conditions that mitigate risks of CAA uptake

Academic and support personnel in universities make interventions on both organisational and operational levels that tend to reduce perceived levels of risk to CAA applications (Table 23).

Intervening conditions	Why?	Where?	When?
Ameliorating Organisational Responses	Good links between CAA team & tutors -tutors trained to use system -tutors trained to write objective items	Academic departments	Just before tools are to be used
Ameliorating Operational Responses	Risks anticipated in procedures -pilot tests before delivery -test system before high-stakes use	Support departments Academic departments	Before tests delivered
	CAA gatekeepers -restricted in number -scrutinise assessments	Support departments	Before tests published
	Subject specialists scrutinise items	Academic departments	Before tests published
	External examiner sees CAA tests	Academic departments	After tests delivered

Table 23- Risk mitigating responses (ph. I axial coding)

Ameliorating Organisational Responses consisted of maintaining good links between the central CAA team & tutors in terms of support departments ensuring that tutors are trained both to use specific CAA systems and to write good objective items. This is best done just before tools are to be used to create CAA tests because of an observed tendency for tutors to forget how to use CAA tools, which are often found more difficult to use than expected. This tendency is exacerbated by the typical pattern of CAA tools being used once a year, whilst instructor-led training is usually delivered when a large enough class list has been compiled with little regard to the timing of CAA tests.

Ameliorating Operational Responses are largely tangible measures taken by support and academic staff in attempts to minimise threats to CAA tests. One key aspect of risk mitigation in CAA appears to be establishing effective procedures and an integral part of this is to anticipate the most serious risks that could threaten assessment exercises. This sometimes took the appearance of a formal risk register. The work seemed to be shared between support departments and tutors working in academic departments but in any event included testing the CAA system before high-stakes use and piloting tests before delivery. Where CAA gatekeepers control access to CAA systems, they work in support departments or in academic departments and have a role to scrutinise assessments, before they are published, for appropriate logical behaviour (as opposed to factual or typographic accuracy which is usually a function of subject matter specialists in academic departments). The number of gatekeepers is restricted to reduce the risks of poor-quality tests slipping into production and the CAA system becoming overloaded. In order to reduce the risk of CAA tests being marginalised, some tutors made arrangements for external examiners to see CAA tests and their results after they have been delivered, even if the university's examination regulations do not require this.

Consequences of mitigating measures

The consequences of risk mitigating measures emerged as a kind of positive feedback effect that tended to elevate uptake. Two consequences of mitigating measures were identified from the phase 1 data, namely *new users attracted in bulk*, the *CAA system becoming overloaded* and *CAA gatekeepers coming increased under pressure* (Table 24).

Consequences	What happened?
New user attracted in bulk	Tutors began to see CAA as an asset
CAA system overloading	Increased traffic caused by improvement in system performance
Gatekeepers under pressure	Gatekeepers struggle to manage existing assessment traffic and cannot cope with influx of extra users

Table 24- Consequences in phase 1 axial coding (ph. I axial coding)

CAA system overloading can occur when inherent scalability restrictions in some CAA systems are brought to the fore because assessment traffic has increased suddenly. These sudden increases in usage occur due to improvements in performance, accessibility and resilience brought about by learning technologists working in support departments and academic departments who have striven to 'protect users from themselves'. CAA systems becoming overloaded puts **gatekeepers under pressure** as they struggle to manage existing assessment traffic they cannot cope with the influx of extra users.

4.7.3 CAA SYSTEM OVERLOADED

Phenomenon of overloaded CAA systems

Some respondents described failures of CAA systems which had apparently been caused by overloading due to three combined conditions (Table 25).

Phenomenon	Why?	Where?	When?
Overloaded CAA system	Scalability weaknesses	Vulnerable CAA systems	Number of simultaneous tests exceeds threshold
	Centralised systems attract new users in bulk	Academic departments	Number of simultaneous tests exceeds threshold
	Successful CAA systems attract new users in bulk	Academic departments	Number of simultaneous tests exceeds threshold

Table 25- The phenomenon of overloaded CAA systems (ph. I axial coding)

Overloaded CAA systems seem to result from latent weaknesses in some CAA software which are exposed when the capacity of the entire system is exceeded. The point at which this happens is reached when the total load on the system increases sharply due to an unexpectedly high level uptake by tutors working in academic departments. This was in turn due to centralisation increasing the credibility and accessibility of systems, combined with a positive feedback effect caused by tutors emulating the practice of successful CAA-using peers.

Causal conditions associated with overloaded CAA service

The two causal conditions that provoked overloading were related to sudden increases in uptake combined with inherent weaknesses in scalability of CAA systems (Table 26).

Causal Conditions	Why?	Where?	When?
New users are attracted in bulk	Centralised service makes CAA service more accessible and more credible	Academic departments	Centralisation
	Tutors emulate successful practice of CAA-using peers	Academic departments	After some CAA tests delivered successfully
CAA is system vulnerable to heavy loads	Some CAA systems can only cope with a limited number of simultaneous sign-ons and are therefore vulnerable to heavy synchronous loads	Support departments	Synchronous usage suddenly increases

Table 26- Causal conditions of overloaded CAA systems (ph. I axial coding)

New users are attracted in bulk when tutors working in academic departments are attracted to using a centralised system because it is more accessible and more credible. Peer pressure to emulate the successful practice of their CAA using colleagues was identified as another reason for large increases in uptake. However, where a **CAA system is vulnerable to heavy loads** there appears to be a hidden threshold of log-ins at which performance for simultaneously-delivered tests, as in invigilated examinations, will degrade in a non-linear fashion. In some web-based CAA systems an unsuspected load point was reached where response time suddenly became so poor that the test had to be abandoned. This is of course exactly the time when CAA systems are expected to behave perfectly, but paradoxically are also most likely to go wrong. This is the particular risk with CAA as opposed to other forms of e-Learning: assessment activities are arguably the most critical things that universities do and a failure in a high-stakes test has serious repercussions.

Consequences of overloaded CAA service

The consequences of an overloaded CAA system are significant for the general uptake of CAA within an institution. The effects are felt by existing CAA users, potential users, CAA gatekeepers and IT departments (Table 27).

Consequences	What happened?
'Horror stories'	Non-users spread news of failures widely
Moratorium on new users	CAA gatekeepers strive to protect vulnerable systems
Scalability requires system tuning	CAA gatekeepers, administrators and IT departments coordinate efforts to maximise existing resources
Scalability requires investment in infrastructure	Scalability requires investment in infrastructure - money
Gatekeepers put under pressure	Gatekeepers struggle to manage existing assessment traffic and cannot cope with influx of extra users

Table 27- Consequences of overloaded CAA systems (ph. I axial coding)

'**Horror stories**' circulate when a CAA failure occurs. The impact of such stories seems to be proportionately greater on non-users than users because non-users have made no investment in learning to use the tools or in setting up tests and have sometimes been observed to pass on bad news with a degree of relish (Harwood, 2003).

Moratoria on new users are enforced by CAA gatekeepers as a mitigating action intended to protect vulnerable CAA systems from further pressure which could precipitate further failures. This depresses uptake. CAA gatekeepers, administrators and IT departments recognise that improved system **scalability requires system tuning**. They coordinate their efforts to make the best use of existing server hardware and network capacity by finding ways of making CAA software behave more efficiently, which is recognised as a non-trivial task due to the complexity of the systems. Where system tuning does not provide required gains in system performance and resilience from existing platforms, institutions may buy into the argument that **scalability requires investment in infrastructure**, particularly server hardware and additional network bandwidth. **Gatekeepers put under pressure** CAA failures put gatekeepers under additional pressure as they struggle to manage the repercussions of the failure in terms of worried users seeking reassurance that 'this can never happen again, can it' (LtO5M001) combined with the additional operational burden of high volumes of assessment traffic that led to the system being compromised in the first place.

Centralising a CAA service

Some universities are providing central CAA services which are often based on existing proprietary CAA software (Table 28).

Phenomenon	Why?	Where?	When?
Centralised CAA services	Centralising pressures	Management Support departments	VLE becomes pervasive
	Trend towards centralised data processing	Support departments	Other services centralised

Table 28- Phenomenon of centralising CAA services (ph. I axial coding)

Centralised CAA services appear to have two related causes in *centralising pressures* from management and/or support departments which may be triggered by perceptions of the productivity benefits of VLEs, which are usually provided as a central service. The *trend towards centralised data processing (DP) systems* such as personnel systems and student record systems appears to have accelerated this trend.

Causal conditions associated with centralising CAA systems

Three related causal conditions emerged as directly associated with the trend towards centralised CAA and were identified as acting both before and after any decisions were made on whether to use CAA or not (Table 29).

Causal Conditions	Why?	Where?	When?
Trend towards centralised DP	CAA system support	IT departments	Before & after decision to use CAA
	Pedagogic support	Support departments	Before & after decision to use CAA
Pervasive VLEs	Manage CAA from VLE	Academic departments	Before & after decision to use CAA
Desire to integrate CAA with MLEs	Search for efficiency & productivity gains	Management IT departments	Before & after decision to use CAA

Table 29- Causal conditions of centralised CAA systems (ph. I axial coding)

A general **trend towards centralised DP** service was identified which stemmed from a desire within IT and learning support departments for economies of scale and ease of administration. **Pervasive VLEs** emerged as a strong centralising factor which stemmed from a desire in academic departments to manage CAA activities from the same VLE that they use for the bulk of their other teaching and learning activity. A **desire to integrate CAA with MLEs** was a specific centralising pressure that stemmed from a desire both within IT departments and from management to develop a managed learning environment (MLE) as a strategic goal.

Process: Consequences associated with centralising CAA systems

Centralising CAA systems had two apparent consequences, namely that new users can be attracted in large numbers and the systems themselves can become overloaded with large numbers of concurrent users (Table 30).

Consequences	What happened?
New users attracted in bulk	Improved accessibility of centralised CAA system
CAA systems become overloaded	Increased traffic

Table 30- Consequences in phase 1 axial coding (ph. I axial coding)

New users are attracted in bulk when centralised CAA systems are introduced due to the sudden availability of an accessible system. **CAA systems become overloaded** when assessment traffic increased beyond a hidden limit, resulting in live catastrophic failures. In some cases entire high-stakes assessments had to be abandoned, in other cases less serious outcomes were reported where a small minority of participants lost their answers.

4.7.4 VISUAL INTERPRETATIONS OF THE PHASE 1 PARADIGM MODEL

Strauss and Corbin suggest that diagrams should be used at as early a stage in the analysis as possible. This is intended both to visually record the emerging relationships discovered between concepts and to assist in actual theory building:

> "Diagrams are very important devices. Their use should begin early in the analysis because they help the analyst think through possible relationships…Diagrammatic displays are not just a way of decorating our conclusions, they also provide a way of reaching them" (Strauss and Corbin, 1998a p. 141)

The act of sketching the relationships between concepts resulted in the consolidation of emerging theory into a simplified, concrete, visual representation. For this reason a purely textual first pass of paradigmatic coding was undertaken before any graphic representations were made as shown earlier in this chapter. Further paradigmatic coding passes were done using a combination of sketching and hierarchical realignments in *NVivo*.

An approach similar to that in chapter 3 was taken to visualise better the interaction of the different concepts (Figure 25). The emergent actions, interactions and consequences in the context of conditions in higher education were considered in abstract terms and their relationships were sketched repeatedly until it made sense. The paradigm was refined through a large number of data/analysis iterations.

4.7.5 MINI-FRAMEWORKS IN PHASE 1

Mini-frameworks, as described by Strauss and Corbin, are a diagrammatic means to represent the interaction of major concepts at the level of their dimensions. They suggest that mini-frameworks are useful for showing gaps in emergent theory and for suggesting hitherto unsuspected interactions between categories (1998a p. 141). A series of mini-frameworks were drawn up to illustrate the intersection of major concepts (and their subconcepts) discovered during axial coding. Measures taken to address organisational and operational vulnerabilities cross-cut critical factors which may work as incentives or disincentives (obstacles and drivers) in the horizontal plane. emboldened lines represent the dimensions of the key categories intrinsic influences and risk mitigating conditions whilst other lines illustrate minor categories (concepts) that are related to the key concepts (Strauss and Corbin, 1998a p. 141). Mini frameworks in this thesis use different weights of dashes to distinguish core categories (shown emboldened). Subcategories are shown with the same kinds of dashes as their parent core categories. An example is shown below (Figure 29).

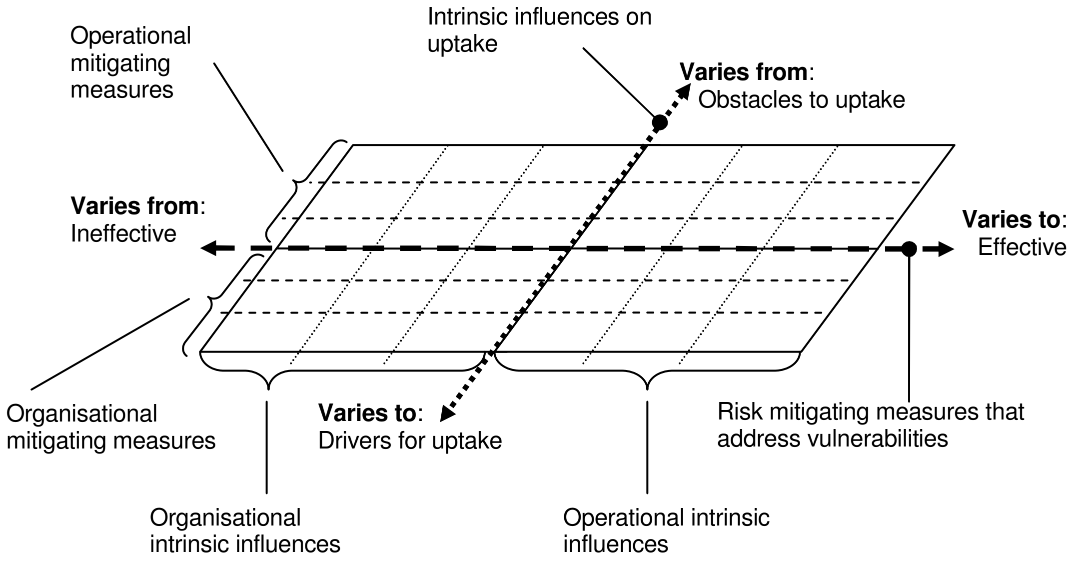

Figure 29- Example mini-framework: tutors' decision making and risk mitigation

The two-dimensional space depicted above shows the interplay of organisational (left-hand side) and operational (right-hand side) intrinsic influences on uptake with mitigating measures on the horizontal axis according to whether they are organisational (upper half) or operational (lower half) in nature. Influences on uptake which are coaxial with the 'intrinsic influences' axis are interpretable as obstacles to uptake if they fall within the hop half of the diagram, otherwise they are considered to be drivers for uptake. Similarly, risk mitigating measures that are coaxial with the 'risk mitigating' axis are construed as relatively ineffective if they are drawn on the left-hand side of the diagram, otherwise they are considered to be relatively effective.

4.7.6 BEGINNING THE GROUNDED THEORY NARRATIVE - PHASE 1

A visual representation of actions, interactions, conditions and consequences was found to be a powerful tool for building theory (Figure 30) A number of important features of CAA applications were made explicit for the first time. For example, obstacles and drivers were categorised broadly as either organisational or operational. This made most sense when these operational and organisational influences were aligned as obstacles and drivers: interactions between these different factors worked either to strengthen or weaken their influence on uptake. For example, decisions by tutors whether to use CAA in assessment activities are directly conditioned by risk aversion which is a basic intrinsic factor conditioned indirectly by the ameliorating effect of learning technologists making CAA easier to use, which is a crucial interaction between two groups of stakeholders.

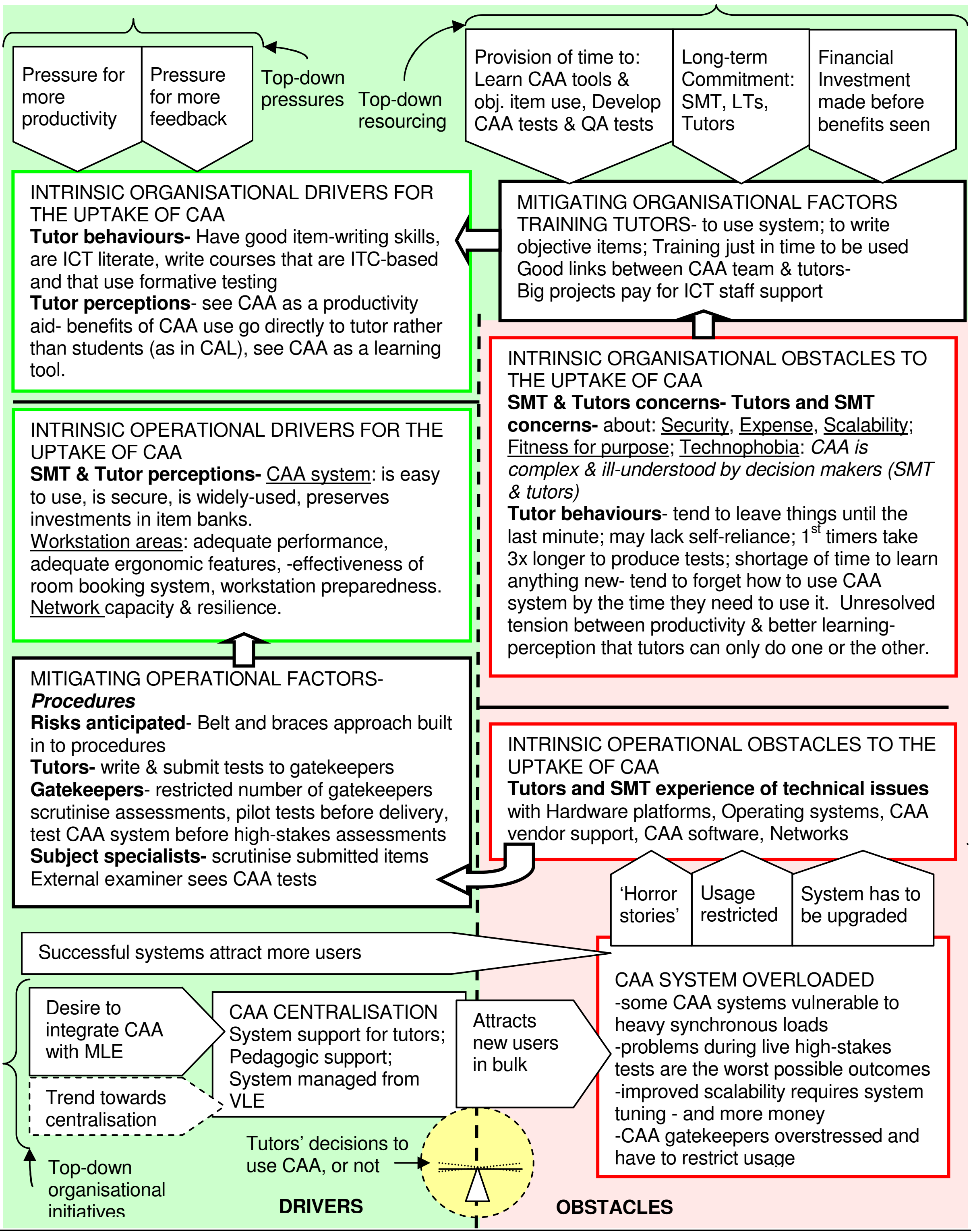

Figure 30- Summary model of relationships between concepts in Phase 1 data

The summary model shows relationships which emerged between the major concepts discovered during open and axial coding. This was felt at the time to be a milestone because it seemed to make sense of a complex field that up that time had not been represented in a straightforward way.

The decisions by individual tutors about whether to use CAA or not is what, at the most fundamental level, really constitutes the uptake of CAA. It seems reasonable to suppose that tutors have in-built susceptibilities to perceived incentives and disincentives for the use of technology in assessment. Ultimately these decisions are taken according to whether the incentives are felt by tutors to outweigh the disincentives, and in figure 31 this is shown with drivers on the left in the green domain and obstacles on the right in the red domain.

Tutors will naturally want to use CAA if they are comfortable with ICT and they see pedagogical and/or productivity benefits: these are intrinsic organisational drivers. It is also natural for tutors to prefer CAA systems that are secure and which preserve their investments: these are intrinsic operational drivers. Conversely, tutors may be uncomfortable with ICT, or naturally averse to technology-based solutions that are unproven as fit for purpose, or are perceived to be insecure or which do not to scale satisfactorily: these are intrinsic organisational obstacles and are opposites of intrinsic organisational drivers. Tutors also have legitimate concerns regarding operational factors such as systems which are unduly difficult to use, or actual (or second-hand) experience of the technology failing in some way: these intrinsic operational obstacles are more the opposites of intrinsic operational drivers. Each set of these intrinsic susceptibilities may be conditioned by extrinsic factors that are largely top-down and organisational in origin and which could themselves be interpreted as obstacles or drivers.

In order to increase the uptake of CAA, attempts may be made to influence the intrinsic susceptibilities of tutors so that inclinations are strengthened and disinclinations are weakened (Lewin, 1944). In this way intrinsic organisational obstacles may be addressed by training interventions and intrinsic organisational obstacles may be weakened by risk mitigating procedures. In order to make the relationships between the diverse factors associated with uptake easier to appreciate I developed a condensed paradigm model that showed only the major categories (Figure 31).

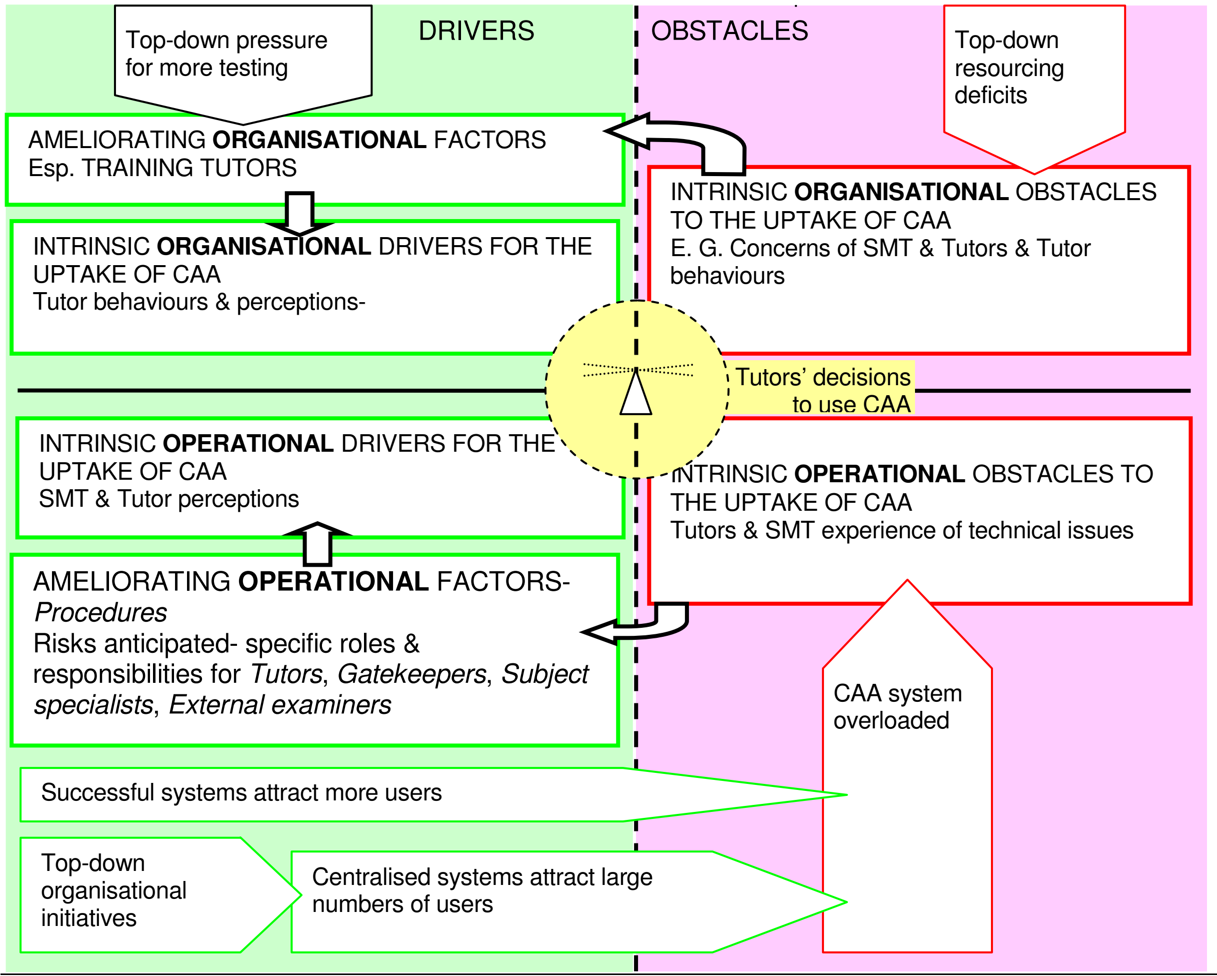

Figure 31- Condensed integrative diagram of CAA uptake (phase 1)

4.8 Beginning the narrative: selective coding

This section begins the process of theory building by describing core categories which leads to selective coding where a core category is used to make sense of the others.

4.8.1 INTRINSIC ORGANISATIONAL DRIVERS

Technology enthusiasts are almost by definition likely to be amongst the early adopters of learning technologies such as CAA, but the interviews revealed other less obvious drivers. Intrinsic drivers are factors that predispose individual tutors to use CAA in their teaching and were categorised as tutor behaviours and tutor perceptions. Behaviours included running courses that used formative testing, were already ICT-based, having good objective item writing skills and being ICT literate. A learning technologist who has many years of experience with helping tutors to use technology in learning and teaching identified these propensities clearly at the level of tutors and students and similar points were made by others:

> … where I've seen it go right, is… where they're going to a web site to get information on a course, to get supplementary tutorial information and handouts and extra references for the course - they're already using IT for - to supplement

> their lectures and seminars… [they are using] web based tools already and just become interested… so they tend to become enthusiasts I suppose and they're already people who are good at adapting to - say - new environments or using new tools and trying them out… (Learning technologist LtO5M001)

Tutors' perceptions that drive the uptake of CAA included whether they see CAA as a productivity aid in the sense that benefits of CAA use go directly to the tutor rather than students (as in CAL) and whether they see CAA as a learning tool. The same learning technologist said:

> I've always found it very much easier to sell CAA than to sell computer aided learning because when you encourage somebody to use CAA the benefits go to the person that's putting the time in, that's the nature of the game. If they put effort into computer aided learning, it's the student that gains… they then look for things that save them time and shows fairly rapid return on the time that they're putting in, its quite easy to sell… (Learning technologist LtO5M001)

4.8.2 EXTRINSIC ORGANISATIONAL DRIVERS

Extrinsic drivers directly influence the decisions of tutors about whether or not to use CAA in their teaching. They include, but are not limited to, the actions and perceptions of senior management teams (SMTs) and learning technologists. The two most obvious external organisational drivers were pressures for more productivity and for more testing. Another experienced learning technologist said:

> … I think everyone in the institution has that sense of pressure of time and looking for different approaches to teaching and learning and technology helping them - with those approaches to teaching and learning. (Learning technologist LtO3M001)

4.8.3 INTRINSIC ORGANISATIONAL OBSTACLES

A set of intrinsic organisational factors to the uptake of CAA were found to be in direct opposition to the organisational drivers discussed above. These were primarily concerns and fears revolving around central themes of security, scalability, fitness for purpose and technophobia. One learning technologists depicted tutors as 'scared that things will go wrong. There's quite a reluctance to actually go into it.' (Learning technologist LtN4F001)

Unhelpful tutor behaviours were identified as a further set of important organisational obstacles. These included tendencies to leave everything to the last minute which militated against quality assurance (QA) procedures and an unresolved tension between productivity and better learning, stemming from the perception that these are mutually exclusive:

> Most of the staff that we tend to work with on an individual level are what I'd describe as innovative staff that can see ICT offers a potential that might enrich the learning experience for their students and come to work with us to explore that

> potential. Some of its pragmatic in term of practicalities. (Learning technologist LtO3M001)

A commonly cited intrinsic organisational obstacle was a lack of resources in terms of time to learn new techniques and new technologies:

> …there's a period where they have to get used to the tool and used to wording their questions to fit into the tool. (Learning technologist LtO2M001)

> [There is] a shortage of people with the time to implement the ideas… (Learning technologist LtN4F001)

The same technologist cited a different set of issues that had to do with doomed attempts to use technology due to a failure to grasp the operational and pedagogical complexity of CAA as the most important single obstacle to the uptake of CAA. According to her, such naïve viewpoints can result in 'misfires' and attendant bad publicity:

> Lack of awareness of the variables that need to be considered before embarking in computer-aided assessment… people embark on this without really understanding all the considerations that need to be taken into account. (Learning technologist LtN4F001)

4.8.4 AMELIORATING INTRINSIC ORGANISATIONAL OBSTACLES

In addition to extrinsic organisational drivers that operated directly on tutors' dispositions to use technology, a set of drivers was identified that work by ameliorating intrinsic organisational obstacles to the uptake of CAA. These were largely concerned with staff development in terms of strengthening tutors' skills to use CAA both pedagogically and in the use of specific CAA systems, in a timely manner:

> So - we have found that the staff training is quite a heavy load but it is very necessary… and what we've found to our horror is that staff training goes stale because the skills aren't reinforced often enough. So that people who were trained in July can't author questions come December. (Learning technologist LtO5M001)

These ameliorating organisational factors appear themselves to be conditioned by top-down resourcing initiatives such as a long-term commitment to making CAA work on the part of SMT, staff developers and tutors and a willingness to make realistic financial investments before benefits are seen:

> [The CAA program has] been in place for about three years and has now showed an improvement in student attainment on that module… [but] the investment actually took place before we got the numbers. (Learning technologist LtO5M001)

4.8.5 INTRINSIC OPERATIONAL DRIVERS

Intrinsic operational drivers for the uptake of CAA were considered to be principally the perceptions of SMTs and tutors regarding the stability of CAA systems and whether they were easy to use, resilient, secure, widely-used elsewhere and to preserve existing investments in item banks.

> Its pretty simple once they understand the architecture… it has a very simple interface… its very quick to master that tool… (Learning technologist LtO2M001)

> The actual technology has to be sound, you have to be committed to it, have good technical support" (Learning technologist LtN4F001)

Other operational drivers included well-prepared and equipped workstation areas, where adequate performance and ergonomics were complemented by the effectiveness of the room booking system.

4.8.6 INTRINSIC OPERATIONAL OBSTACLES

The intrinsic operational drivers described were opposed by intrinsic operational obstacles. These are principally to do with experience of technical issues including problems with hardware, CAA software and workstations: '…computer networks aren't 100 percent [pause] reliable so we tend to be very careful…' (Learning technologist LtO2M001)

> … I've seen it go wrong … when someone's results didn't get stored, the student's responses didn't get stored and so they had to do the assessment again, which was not very satisfactory… that was due to a technical problem with the software. (Learning technologist LtN4F001)

4.8.7 EXTRINSIC OPERATIONAL DRIVERS

Intrinsic operational obstacles are ameliorated by the influence of risk management procedures such as risk registers and procedural devices:

> We're very careful to make sure that there's no room for sort of - technology failure because the computer networks aren't 100 percent reliable so we tend to be very careful and just make sure that everything's sort of - the rules of engagement are defined and any areas of vulnerability are covered. (Learning technologist LtO2M001)

4.8.8 THE SHIFT TOWARDS CENTRALISED CAA SYSTEMS

The emergence of managed learning environments (MLEs) appears to drive the development of centralised CAA systems. Once CAA systems are available to entire institutions along with collateral support from learning technologists and staff developers, uptake may increase beyond expected or sustainable limits: "…the take-up was so high - so much higher that it led to fairly spectacular problems with it…" (Learning technologist LtO5M001). This in itself led to access to the system being restricted and some unfavourable publicity.

4.8.9 SELECTIVE CODING IN PHASE 1

The essence of selective coding is to isolate one central core concept to which all other concepts can be related (Strauss and Corbin, 1998a pp. 146-148) and then to develop a narrative that describes what appears to be happening (1998a pp. 48-153). It had emerged that in order to understand institutional uptake of CAA one has first to know how tutors come to decide whether to use CAA or not. This appears to be a dynamic process which is heavily influenced by intrinsic inclinations and disinclinations, but which can be influenced by measures designed to address some of the common, important obstacles such as perceptions of system reliability and fitness for purpose. The core concept in phase 1 was **tutors' decision making** about whether to use CAA or not and this emerged during axial coding when the paradigmatic model was developed (Figure 31).

The organisational processes appeared to be mostly concerned with balancing perceptions of risk, particularly at the level of tutors who were active or potential CAA users. The operational processes were mainly associated with building and running the system itself and with establishing and enforcing procedures for risk management by mitigating actions and contingency planning. The extent of CAA uptake appeared to depend on the extent to which the intrinsic concerns of tutors were addressed by the risk management procedures of the CAA specialists.

Strauss and Corbin encourage grounded theorists to step back from the analysis at frequent intervals and ask 'what is going on here' (1998a p. 45). This interpretation of a complex process made previously un-suspected relationships explicit and raised a number of pertinent questions. For example, the small sample in Phase 1 lacked authority: were there other obstacles and drivers in addition to those mentioned by the phase 1 respondents? Which were the most important ones? What is the nature of the relationship between CAA uptake and good/poor outcomes from existing CAA applications? How important is ease of use?

4.8.10 THE DISCOVERY OF AMPHOTERIC FACTORS

In Chemistry, a substance that behaves as an acid under some conditions and a base under others is described as *amphoteric*. The *Oxford English Dictionary* defines the word 'amphoteric' as 'Chiefly *Chem.*, having or exhibiting both acidic and basic properties' (OED, 2004). It comes from the Greek root ἀμφότερος meaning 'each of two' (Wikipedia, 2005a).

Once the concepts discovered in open coding had been depicted as a paradigm during axial coding, it became clear that the apparent positive feedback loop whereby increased use of CAA encouraged non-users to try it was not as simple as it had appeared. If the CAA system became overloaded as a result of this increased uptake, CAA usage could actually decline as a consequence of gatekeepers restricting access to the system and concomitant adverse publicity. One of the gatekeepers said:

> …clearly when you get failures its very easy to doubt because when you get failures its very public… and in the light of that we've actually banned taking new users, we're only taking existing people at the moment. Because we just can't cope… (Learning technologist LtO5M001)

Increased uptake of CAA is amphoteric in the sense that it behaves as a driver for the uptake of CAA when the CAA system is unloaded, but switches to an obstacle when the CAA system becomes overloaded.

4.9 Emergent theory in Phase 1

A symmetrical 'cloverleaf' composition of factors was developed from the phase 1 integrative diagram of CAA uptake which was intended to provide a better description of the interaction of factors that comprise underlying mechanisms governing the uptake of CAA (Figure 32). *Decisions of tutors whether to use CAA or not* was chosen as the core category and other features were restricted to major categories. This meant omitting detail such as the feedback loop whereby increased uptake further increases uptake, but gave a wider perspective of the problem. This made gaps in the emergent theory more apparent. Questions arose regarding the existence of other amphoteric conditions and how external operational drivers and obstacles influences uptake.

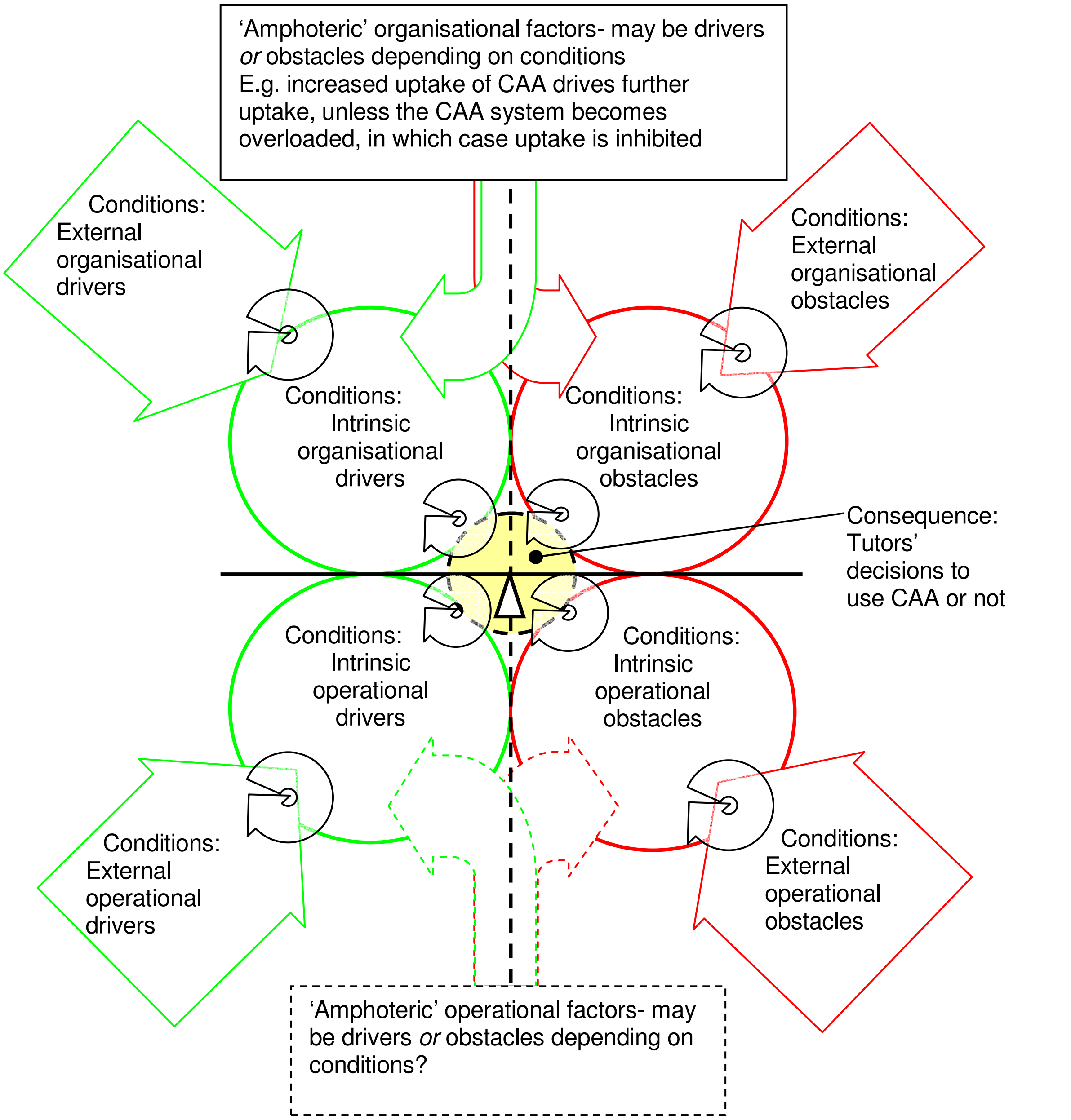

Figure 32- Abstracted 'cloverleaf' model of CAA uptake (derived from Figure 31)

4.9.1 IDENTIFYING GAPS IN THE EMERGENT THEORY

The mini-framework (figure 30) made it clearer which sub-categories interacted in significant ways with other concepts, particularly the symmetrical, almost one-to-one mapping of organisational mitigating measures against organisational obstacles. However, the most useful aspect of the mini-framework turned out to be identifying gaps in the emergent theory. For example, one of the gaps exposed was the lack of any sense of a time dimension and this is explored in the next two chapters. The data had been obtained from a relatively small sample of learning technologists who had developed and set up many CAA tests. As such, it was their impressions regarding what made CAA work well or not. However, it did not indicate how the

CAA careers of tutors might change through time, nor what the influence of intrinsic and mitigating factors might be in adjusting the courses of these careers.

Another gap which was highlighted by the mini-framework was the relative importance of different negative and positive influences on the uptake of CAA. Although the various influences that emerged from the phase 1 data are disposed along an axis according to whether they are seen to behave as obstacles or drivers, there was little evidence in the phase 1 data to indicate strength or importance. The small Phase 1 sample had shown considerable agreement with the existing literature in terms of the kinds of factors commonly identified as obstacles and drivers, such as shortage of time as an obstacle, but some of the factors identified in Phase 1 appeared to be new (they did not appear in the literature). The clearest example of this was the disastrous effect on CAA uptake of some kinds of technical failure. In fact, failures of any kind during CAA tests appear to be under-reported in the literature. The second cycle of data collection and analysis was set up to address these two important shortfalls in the emerging theory.

To summarise, three gaps were identified in the emergent theory:

1. Which are the key factors influencing tutors' decisions regarding CAA use?
2. To what extent do the perceptions of stakeholders (senior management, tutors and learning technologists) vary?
3. To what extent is the balance of drivers and obstacles static because tutors make up their minds early on and to what extent is it dynamic because they are susceptible to persuasion or dissuasion? A related issue is what, if any, other cultural or operational factors are amphoteric?

4.9.2 THEORETICAL SAMPLING

It was becoming clear that the learning technologists, all of whom has considerable experience in CAA and who had expert status, thought that CAA uptake was driven directly by tutors' inclinations, skills and experience. These propensities were thought to be strongly conditioned by effective mitigating actions. However, no tutors had been asked for their opinions on the matter; did CAA users perceive the same model of uptake? Conversely, did non-users see things the same way? What about senior management teams (SMTs) and other learning technologists? Do CAA users (tutors and student participants) perceive things the same way?

Another obvious question was whether the obstacles and drivers identified and modelled from the responses of learning technologists were the same for other stakeholders such as tutors and managers. For example, which factors were more important to tutors? More data was required to answer these questions and it was clear that this would have to come from tutors and managers in addition to a larger sample of learning technologists and staff developers.

4.10 Chapter summary

This chapter comprised the first part of the data theory section. It described the first phase of data collection and GT analysis which constituted a preliminary basis for the large scale data collection and analysis exercise undertake in phase 2. It concluded with a summary model of the relationships discovered between key concepts that had emerged from the data. Some gaps in the emergent theory were identified and actions proposed to fill them. The next chapter presents an account of how gaps in the data were filled during Phase 2 data collection and analysis and how the emergent theory was refined.

5 Phase 2 Data Collection and Analysis

This chapter comprises the second element of the data theory section. It describes the steps taken to flesh out the emerging theory of how CAA uptake develops in universities and begins with a recapitulation of the previous phase of data collection and analysis which is followed by a summary of the perceived gaps in emergent theory. A description is given of the second phase of data collection that was designed to address these gaps and of the phase 2 analysis which portrays the discovery of important concepts together with their properties and dimensions during open coding. This leads to a description of the axial and selective coding processes where the emergent theory is further developed. The emergent theory is presented. A third and final phase of data collection and analysis is described in the next chapter (chapter 6) during which the emergent theory was presented for verification by expert tutors, learning technologists, quality assurance staff and managers.

5.1 Introduction to phase 2 activities

This section presents an account of the theoretical sampling used to address gaps in the data during the Phase 2 data collection and analysis process and how the emergent theory was correspondingly refined. It should be noted that the same approach which was taken to open and axial coding in phase 1 (discussed at length in chapter 4) is used in phase 2. In order to avoid taking up a significant volume of the thesis with detailed descriptions of the categories which emerged from the data and how their properties and dimensions were identified, the tables and description rendered in chapter 4 should be taken as an illustration of the way these tasks were managed in phase 2. However, summaries of adaptations and amendments made to the emergent theory in the light of the fresh data that was collected in phase 2 are provided here, together with rationales for making such alterations.

5.1.1 RECAPITULATION OF PHASE 1 DATA COLLECTION AND ANALYSIS

During the first phase of data collection and analysis, learning technologists, all of whom has considerable experience in CAA and had expert status, were asked what they thought made CAA work well in their experience. In view of the pilot nature of the initial data collection/analysis phase, the interviews had been kept near the unstructured end of the continuum and the questions asked were as open as possible (Oppenheim, 1992 pp. 51-52). An interpretation (hypotheses are not generated at this stage in GT studies) of the opinions collected from these learning technologists was that CAA uptake is driven directly by tutors' inclinations, skills and experience. The influence of these internal propensities was augmented by external influences such as pressures for greater productivity and mitigating actions.

The opinions of learning technologists had been sought exclusively in phase 1, in order to achieve at least a partial understanding of how expert learning technologists understood the processes involved in CAA uptake. It seemed likely that some factors would prove to be more important to some stakeholders than to others, or that some factors might even be specific to specific sets of stakeholders. Gaps identified in the emergent theory included the following:

1. Which are the key factors influencing tutors' decisions regarding CAA use?
2. To what extent do the perceptions of stakeholders (senior management, tutors and learning technologists) vary?
3. To what extent is the balance of drivers and obstacles static because tutors make up their minds early on and to what extent is it dynamic because they are susceptible to persuasion or discouragement? Related to this question is the issue of what, if any, other *cultural* or *operational* factors are 'amphoteric'?

I assumed that in addition to furnishing initial data that would determine the course of the investigation, the first phase of data analysis would act as a pilot of the data collection and analysis techniques used during the main part of the study (section 3.6). I wanted to apply lessons learned from the pilot (phase 1) to the larger scale exercise in phase 2.

I envisaged that a large-scale data-gathering exercise would be needed not only to address perceived gaps in the emergent theory generated in the previous section, but also to strengthen the validity and relevance of the findings (chapter 3). In order to fill the gaps and approach theory saturation a good deal more data would be needed from key stakeholder groups. These were identified in phase 1 as tutors, staff developers, senior management and learning technologists. In fact the only real difference between the pilot study in phase 1 and the large-scale exercise undertaken in phase 2 was that in addition to Likert scale 'closed' questions, the phase 2 questionnaire also contained a set of open questions that could be used to collect free-text responses which could be used as data in the GT analysis.

5.1.2 OVERVIEW OF PHASE 2 ACTIVITIES

The sequence of data collection and analysis undertake in phase 2 was that a national survey of CAA use was launched in two stages, the results being analysed after each. A UK CAA national survey by questionnaire was delivered online to tutors, learning technologists and QA staff during the summer of 2003 and the results collected. Open and axial coding was performed during the autumn of 2003, the results of which conditioned the questions asked of tutors during face-to-face interviews with tutors during the autumn of 2003.

Open and axial coding was performed on all the data collected during 2003 and in the summer of 2004 the UK CAA survey was re-launched online and made available to tutors, learning technologists and QA staff. The interim results of the 2003/4 exercises conditioned questions asked of learning technologists during personal interviews held in the autumn of 2004. A further cycle of open and axial coding was performed that incorporated this new interview data which was completed during the winter of 2004/5. Selective coding was performed during the spring of 2005 and the resulting emergent theory was tested and verified during the third and final phase of data collection and analysis, described in the next chapter (chapter 6).   This sequence is summarised below (Figure 33) where data collection activities are shown above the central horizontal dotted line and data analysis activities are shown below it.

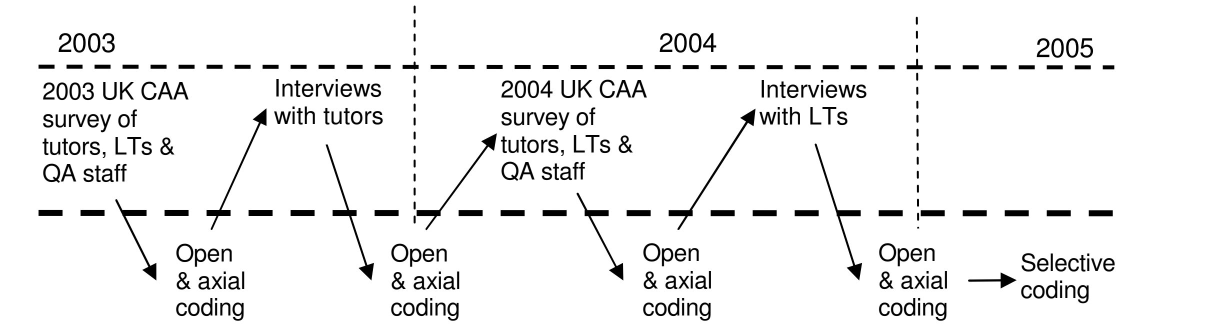

Figure 33- Sequence of phase 2 data collection and analysis activities

This is shown as a summarised form in context with the full data collection and analysis scheme (Figure 33). Phase 2 activities were shown earlier in the study's context (Figure 19).

5.1.3 PRESENTATION OF PHASE 2 DATA COLLECTION AND ANALYSIS ACTIVITIES

Although the four separate data collection and analysis stages which comprise the second phase of the study were conducted strictly according to the sequence described above, in the interests of clarity they are presented here in the following order:

- Phase 2 data collection
    - 2003 national CAA survey
    - 2003 interviews with learning technologists
    - 2004 national CAA survey
    - 2004 interviews with tutors
- Phase 2 data analysis
    - Open coding
        - 2003/4 questionnaires
        - 2003/4 interviews
    - Axial coding
    - Selective coding

It will be seen from this that the data collection stages are presented in chronological order and that the four data analysis stages have been conflated into two parts, namely analysis of the national survey responses and analysis of interviews with tutors and learning technologists. It was felt that the resultant benefits of clarifying the narrative outweighed the disadvantage of losing the strict chronological sequence in which the analyses were performed.

5.2 2003 national CAA survey by questionnaire

This section presents an account of the second phase of data collection that was designed to address the gaps in the emergent theory described in section 5.1.

Data was received from the 2003-4 surveys in two forms: returns from questionnaires and interviews conducted either face-to-face, or, where this was impractical, by telephone. For reasons explained later in this chapter, the questionnaire was distributed in two stages, one in the summer of 2003 and the other in the summer of 2004. In both cases, the questionnaire data was analysed before interviews were conducted. Thus a relatively large number of questionnaire returns were expected to reveal the bulk of the CAA community's current concerns, which were investigated during personal interviews.

5.2.1 COMPILING THE PHASE 2 (2003) ONLINE SURVEY INSTRUMENT

For this second round of data collection, a national survey of tutors, staff developers, senior management and learning technologists by questionnaire and interview was undertaken. The survey instrument used in phase 1 which had been adapted from Beetham's (2001) JISC-funded learning technologist institutional audit tool was used at the beginning of the study because it is a highly developed and tested means for identifying the concerns of learning technologists. At that early stage in the study, little had been known of the specific concerns of the CAA community and it was felt that adapting this general purpose tool would be a suitable way to gather the widest possible range of impressions from the subjects.

The phase 1 survey instrument was therefore considered as a candidate for the basis of the phase 2 survey instrument. However, feedback received from a meeting early in 2003, which included learning technologists who had been included in the phase 1 questionnaire sample, indicated very strongly that a more suitable basis for the planned large survey would be the national CAA survey that the LTSN-funded CAA Centre conducted in 1999. The reasons for this were that the 1999 survey had been designed specifically to probe the needs of the CAA community in great depth and the present study's need for a large-scale survey of the CAA community would provide the opportunity to run a successor survey, on a similar scale, which could also provide useful comparisons with the 1999 survey and also with an earlier UK survey (Stephens and Mascia, 1997).

Another compelling reason for basing the design of the 2003 survey on the 1999 survey was the desire to ascertain how the use of CAA in UK universities had changed in the four years that had elapsed since the 1999 study. Four years had also elapsed between the CAA Centre's 1999 national CAA survey and Stephens & Mascia's 1995 national survey (Stephens and Mascia, 1997) upon which it had been based (Bull, 1999).

The original 1999 questionnaire forms were examined and the published findings were studied (Bull, 1999; Bull and McKenna, 2000; Bull et al., 1999). The raw data were not available for comparison because they had been destroyed in compliance with the Data Protection Act. The 1999 questionnaires were considered to be a better basis for the 2003 survey than Beetham's (2001) survey of learning technologists, but it seemed desirable to include additional questions about the influence of VLEs, plans for MLE development and the profile of interoperability as obstacles or drivers. This was to test whether these technologies and CAA activities in particular, had become more embedded since the last survey. Only one of the 1999 questions was replaced because it was no longer relevant (it asked whether a National CAA Centre would be helpful). The 2003 questionnaire is reproduced in Appendix B.

In addition to open questions that were answerable in free text fields, which were directly susceptible to GT analysis techniques, there were also a large number of closed questions, the answers to which could not be easily brought into the theory building process. This was anticipated at the outset and it was intended that they might be used at the end of the GT process to help position the emergent theory. It was also intended to provide a useful snapshot of the development of CAA since the earlier national CAA survey in 1999 and for that matter its 1995 precursor (Stephens and Mascia, 1997).

Validity

The phase 1 analysis had raised two issues of validity:

1. To what extent would the emergent theory of CAA uptake developed from the perceptions of a small group of learning technologists be supported by the wider CAA community? This is addressed in section 5.7.6. .

2. Do different stakeholder groups (tutors, staff developers, senior management and learning technologists) have common perceptions of factors that were

regarded as obstacles or drivers by the CAA expert learning technologists in phase 1? This is addressed in sections 5.9.3 and 5.9.4.

Questions were therefore included to gather demographic data such as institution type and job function (item 2 above). The 2003 questionnaire contained a number of open questions that were designed to capture respondents' beliefs and attitudes to the uptake of CAA (item I above). The open questions are listed below (Table 31).

Open questions in 2003/4 national survey questionnaire
7. (a) Please list any advantages to using CAA that you have identified: (b) Please list any disadvantages to using CAA that you have identified:
8. What do you see as the critical success factors for the implementation of CAA? (a) At level of the individual academic (b) At level of the institution
9. What do you see as the main obstacles to the successful implementation of CAA? (a) At level of the individual academic: (b) At level of the institution:
11. Would any of the following be useful in supporting your use of CAA? (For each please specify further details.) (a) Staff development .... (b) Institutional support .... (c) National support .... (d) Hardware provision .... (e) Software provision ....
12. What future developments in CAA would you like to see?
20. Do you receive support from any of the following for your use of CAA? (Please specify what form this support takes, e.g. funding, time released, staff, additional hardware/software resources.) (a) Department (b) Faculty (c) Institution (d) External (e) Other
22. What do you see as the particular advantages and disadvantages of the CAA software you use?
23. If academic staff at your institution use CAA, is it your view that they are saving their own time… if so, please give details of who, how and number of extra hours per week.

Table 31- Open questions in 2003 national CAA survey questionnaire

5.2.2 DISTRIBUTING THE 2003 QUESTIONNAIRE

The 1999 survey had been distributed both online and by paper-based mailing to known individuals and to a wider constituency of people identified by job title and institution. Electronic versions of the survey were distributed by mail-base list and from the CAA Centre's web site and the results triangulated against face to face interviews with key individuals and focus groups. However, the 2003 survey was distributed using purely on-line techniques in the interest of cost containment and because of the limited amount of time available. A virtue was made of necessity in that the benefits of doing this were to include both speedier returns and an increased return rate (Coombes, 2001 pp. 119-121).

A decision was made to publish the 2003 online survey using a commercial hosting service, largely on the grounds of avoiding any appearance of bias due to hosting at the parent institution. It was launched in mid-2003 and made available via a set of mailing lists that were known to be heavily used by learning technologists and CAA practitioners including the Association for Learning Technology (ALT) bulletin and the generic JISC CAA list as well as several JISC-sponsored subject specialist CAA lists. The administrators of these lists were asked about membership sizes, from which it was estimated that the potential audience for the survey was around 800 unique individuals.

5.3 2003 Interviews with learning technologists

5.3.1 DESIGN OF THE PHASE 2 INTERVIEW SCHEDULE

In order to balance the views of learning technologists which had been analysed in phase 1, a set of interviews was arranged with tutors. The phase 1 semi-structured interview schedule had been derived from the survey of expert CAA learning technologists that was conducted at the outset of the study and this is shown (Table 32) for comparison with the approach adopted in Phase 2.

Phase 1 interview schedule	
1 Culture: To what extent does your institution commit real resources to CAA?	
1 (a)	What kind of commitment does your HEI have to CAA at an institutional level?
1 (b)	Infrastructure: to what extent has the institution integrated CAA into its practice?
1 (c)	Tell me about your HEI's CAA procedures?
1 (d)	If they exist, what relation do they have with the University's exam procedures?
2 Expertise: What CAA skills and experience do the institution's staff and students have?	
2 (a)	Tell me about the kind of testing you do?
2 (b)	How long do people take to get familiar with the system?
3 Targets: What distinguishes good CAA applications from poor ones?	
3 (a)	What are the pitfalls to watch for when implementing CAA?
3 (b)	Do you have any anecdotes, or interesting experiences with CAA?

Table 32- Summarised phase 1 interview schedule

In phase 2 the same strategy of using the schedule as a starting point to stimulate discussion was used. The interviews generally proceeded with little need for prompting from the interviewer, although in some cases a little guidance was required to keep the interview on topic. The schedule was extended to accommodate issues that had provoked respondents in the questionnaire returns, which included the effect on practioners' careers of specialising in CAA (5(c)) and the effects of CAA failures on uptake (4(b)). The extended phase 2 interview schedule is shown below (Table 33).

Phase 2 interview schedule	
1 Culture: To what extent does your institution commit real resources to CAA?	
1 (a)	What kind of commitment does your HEI have to CAA at an institutional level?
2 Infrastructure: to what extent has the institution integrated CAA into its practice?	
2 (a)	Tell me about your HEI's CAA procedures?
2 (b)	If they exist, what relation do they have with the University's exam procedures?
3 Expertise: What CAA skills and experience do the institution's staff and students have?	
3 (a)	Tell me about the kind of testing you do?
3 (b)	How long do people take to get familiar with the system?
4 Targets: What distinguishes good CAA applications from poor ones?	
4 (a)	What are the pitfalls to watch for when implementing CAA?
4 (b)	Do you have any anecdotes, or interesting experiences with CAA?
5 Obstacles and drivers: What encourages CAA uptake?	
5 (a)	What factors promotes the growth of CAA?
5 (b)	What factors impede the growth of CAA?
5 (c)	Is using CAA good for the careers of practitioners?

Table 33- Summarised phase 2 interview schedule

Some of the phase 2 interviews were conducted by telephone because face-to-face meetings were impractical. The importance of ensuring that questions and responses were clearly understood was recognised (Drever, 1995 pp. 15-16) and particular care was taken to avoid ambiguity in the telephone interviews because of an obvious lack of visual cues. A total of seven tutors agreed to be interviewed at this stage, all of who had used CAA. The degree of experience amongst the group varied from several years to less than a year and with the extent of practice from a range of different CAA applications and stakes in the case of the most experiences tutor, to a single CAA test in the case of the least experienced tutor. All the tutors interviewed worked in the same institution, which is a Russell Group university.

5.4 2004 national survey by questionnaire

When the results of the 2003 UK survey by questionnaire had been partially analysed, it was agreed that the 2004 survey should be targeted more toward named individuals in 160 institutions including CAA specialists, heads of IT, heads of L&T, Institutional/ Faculty/ Departmental L&T coordinators and heads of department. It was also decided at the same time that the 1999 strategy of distributing a paper version would not be followed due to the high estimated cost of distribution and difficulty of retrieving results. However, key personnel such as institutional quality assurance (QA) and heads of learning and teaching (L&T) were invited to participate in the survey.

5.4.1 IMPROVING THE RETURN RATE

The 2003 survey had been published by a commercial provider. In fact, out of 800 possible respondents, 151 attempted the 2003 pilot survey but only 50 usable responses were received, many of which were incomplete. Despite this high (67%) non-completion rate no reports were received from any respondents who had experienced difficulties in completing it. Because respondents who had not submitted their attempts were untraceable, it was unknown whether this was due to usability problems with the instrument, or for some other reason. It was therefore decided to eliminate the platform as a cause for low returns by hosting the 2004 full survey using the JISC-funded Tools for Interoperable Assessment (TOIA) CAA system, which was made publicly available in June 2004. The instrument was also made easier to use and in order to further reduce the high non-completion rate a 'core' subset of the survey instrument was offered in addition to the full version. An analysis of incomplete 2003 responses revealed a small number of items where respondents had apparently abandoned their attempts to complete the questionnaire. The 'sticking points' in the 2003 pilot appeared to be with the following items:

Q.6: a five-point Likert scale question (in 26 parts) asking about attitudes towards different affordances of CAA

Q.19: a complex multi-part question asking for the details of the respondent's last eight assessments

Q.20: a free text question in five parts asking about resourcing of CAA

These were in every case the more onerous items. Two strategies were considered for reducing the dropout rate: either to make the core subset less onerous, or to omit those items and parts of items which had apparently caused respondents to abandon their attempts.

After consultation with academics and learning technologists, it was agreed that the survey should be made easier to complete. In particular, the wording of many items was optimised for clarity and conciseness and the order of questions within the survey was optimised so that, for instance, the most onerous item was placed at the end of the survey in order not to discourage respondents before they had answered the bulk of the questions (Oppenheim, 1992). By June 2004, the draft survey instrument had been reviewed with two survey specialists, two learning technologists and two academics. The consensus was that it was still too long, so some of the more onerous items were rationalised (Appendix C). The survey was reviewed by the same people who agreed that it was now the irreducible minimum if the results were to be strictly comparable with those of the 1999 survey.

5.4.2 DISTRIBUTING THE 2004 SURVEY INSTRUMENTS

Some formatting problems were evident at first and although these were fixed by the TOIA team within a few days, it was apparent that the completion deadline would have to be postponed from the end of July to the end of August 2004. Unfortunately this coincided with the beginning of the summer holiday for most universities.

The survey was launched at the 2004 International CAA Conference, which attracts an audience mainly of enthusiasts. Invitations were also issued via a number of email distribution lists including JISC-CAA, MATHS-CAA, LAW-CAA, ALT and the LTSN subject coordinators' lists. In order to widen participation beyond the e-learning enthusiasts who could easily be reached in this way, the involvement of other stakeholders including quality assurance (QA) and learning and teaching (L&T) personnel was sought. The LTSN office supplied a list of anonymised institutional QA and L&T heads and their postal addresses. 160 institutions of Higher Education were identified as possible users of CAA. Budgetary constraints permitted a maximum of 320 letters to be sent which went to the head of Learning and Teaching and to the head of academic Quality Assurance at each institution. Each letter was individually addressed according to the LTSN-derived job title and carried an invitation to participate in the survey with details of how to access the survey website. Recipients were also invited to distribute the survey internally.

5.4.3 FURTHER TECHNICAL PROBLEMS WITH 2004 SURVEY

TOIA - the CAA system used to distribute the 2004 survey - only supports Microsoft Internet Explorer 6 (MS IE6) and 'pop-up' blockers must be turned off. Owing to a number of well-publicised weaknesses in MS IE6 around the time the survey was launched, many academic users were not using that browser at all. Furthermore, feedback from putative respondents indicated that 'pop-up' blockers were in widespread use and many were unable or unwilling to disable them in order to access the survey. Accordingly, the TOIA support team at Strathclyde University very generously made alternate versions of the survey tool available which were 'hand-coded' in HTML and which worked with 'pop-up blockers' and other browsers.

5.5 2004 interviews with learning technologists

One of the insights which emerged from phase 1 and 2 data was a tension between learning technologists who focus on making the best possible use of CAA technology and the tutors they support who have a more pragmatic view of CAA as a means to an end. Tutors wanted to do a 'good enough' job so that assessment tasks were performed in a time efficient manner, whereas learning technologists seemed to worry more about assessment theory and making assessments 'water tight'. Opportunities were sought to investigate this further by conducting interviews with well-placed and experienced learning technologists. Four interviews were conducted using the same schedule as in the phase 2 interviews with tutors. The verbatim transcripts were sent back to the respondents for approval and then analysed in the same way as in phase 1.

5.6 Phase 2 data analysis

5.6.1 CODING 2003/4 QUESTIONNAIRE RETURNS

Free-text responses were coded using the phase 1 procedure (section 4.5). Some additional factors were identified and coded using an updated version of the phase 1 *NVivo* project. The total number of words in the form was subtracted from each questionnaire return and the total (53 587) was divided by the number of returns (187) to give an average of about 270 words for each return. As is often the case with questionnaire surveys of this kind, a large number of returns contained little more than the minimum possible responses whilst others contained comprehensive responses which were sometimes just as informative as responses received in face to face interviews (Warburton, 2002).

It should be noted at this point that the responses received were a superset of the CAA expert learning technologists' responses in that the same obstacles and drivers reappeared. As expected, the increased number of respondents combined with the opportunity for more structured responses resulted in a more elaborate model which will be shown in section 5.10.

5.6.2 CODING DEMOGRAPHIC DATA

In order to preserve key demographic attributes of respondents without compromising anonymity, a coding scheme was adopted which included job type, subject specialism, type of institution, age and gender. These demographic codes took the form 'JsUAGnnn', where:

'J' denotes Job type: A = 'academic teacher', L = 'learning technologist', Q = 'quality assurance (QA)'
's' denotes Subject: m = 'mathematically-based', s = 'social science', h = 'humanity'
'U' denotes Institution type: O = 'old' (pre-1992) University, N = 'new' (post-1992) University
'A' denotes Age: 2 = '20s', 3 = '30s', 4 = '40s', 5 = '50s', 6 = '60s'
'G' denotes Gender: F = 'Female', M = 'Male'
'nnn' denotes an index number that differentiates respondents with similar attributes

To illustrate, 'AmO5F001' indicates the first example found of a male academic teacher in his 50's specialising in a mathematically-based subject and who works in an old (i.e. pre-1992) university.

5.7 2003/4 national surveys by questionnaire

5.7.1 ANOMALOUS RESPONSES

When encoding the responses to 'open' questions about obstacles, particularly in online questionnaire returns, it was often found that respondents had entered the 'driver' version of what would normally be considered to be obstacles. As an example, several people simply entered 'time' as a critical factor impeding the uptake of CAA, rather than writing more fully 'lack of time'; similarly the respondent entered 'competence' as a obstacle rather than writing something less ambiguous such as 'lack of competence' or simply 'incompetence'. If these responses had been taken at face value they might be interpreted as 'having enough time is an obstacle to the uptake of CAA'. However, it was thought likely that such complex statements would be supported by less ambiguous wording, so all such cases were interpreted as simple obstacles.

5.7.2 OPEN CODING OF 2003/4 ONLINE SURVEY RESPONSES

The 2003 online survey attracted 43 usable responses. Of these, about two fifths (16) described themselves as learning technologists and around three fifths (27) were academic teachers (tutors). The reissued 2004 questionnaire attracted nearly three times as many (123) usable responses, of which seven had quality assurance (QA) functions, 31 were learning technologists and 85 were tutors. Of these, 15 were eventually discarded because they were duplicate attempts or were found to be missing critical data or turned out to be from non-UK (or non-academic) institutions. This gave a total sample size of 151 of which 75 were from old universities and 76 were from new universities. The free-text components were coded in the same way as the phase 1 interview transcripts. Some additional factors were identified and coded using an updated version of the phase 1 *NVivo* project. It was noted that the responses appeared in many ways to be a superset of the CAA expert learning technologists' responses.

Responses to items asking about critical factors at the level of individual academics and at institutional level were, to begin with, coded as cultural or operational intrinsic and extrinsic obstacles and drivers. Factors identified by respondents as advantages or disadvantages of CAA (Q.7) were mostly interpretable as obstacles or drivers at the level of individual academics.

5.7.3 UNIPOLAR AND BIPOLAR FACTORS

Some factors were very obviously pairs of obstacles and drivers. For example, 'provision of time' was always cited as a driver whilst its' absence was always cited as an obstacle. In chapter 4 I named these 'bipolar' factors. A few factors were found to be cited exclusively as either drivers or obstacles. For example, **enthusiasm** in tutors was invariably cited as a driver whilst **inertia** at any level was always cited as an obstacle. I named these 'unipolar' factors.

5.7.4 OPEN CODING - MANAGING THE GROWTH OF THE CODING SCHEME

The coding scheme grew from fewer than 200 in Phase 1 to more than 500 nodes after only half the 2003 questionnaire returns had been processed. This was a lengthy process, due mainly to the difficulty of deciding how best to code the wide variety of open responses without losing precision or allowing them to proliferate unduly. Transcriptive open coding was therefore suspended at this point in order to rationalise the scheme, which entailed the discovery of categories. This approach is part of the iterative 'constant comparative' process legitimised by Strauss and Corbin as one element of open coding:

> "Once we have opened up text and have some concepts, where do we go next? In the course of doing analysis, an analyst might derive dozens of concepts… Eventually, the analyst realises that certain concepts can be grouped under a more abstract higher order concept, based on its ability to explain what is going on" (Strauss and Corbin, 1998a p. 113)

The coding scheme was rationalised by first inspecting all the concepts for common themes which could be used to categorise them and then collecting such concepts into hierarchical structures. Once all the concepts had been categorised in this manner, it became easier to identify concepts that appeared on closer examination to be more or less coding the same underlying phenomenon. After re-examining the actual data, it was often possible to merge such concepts. This sometimes entailed changing the names of concepts to more accurately reflect the nature of phenomena.

As an example of taking a step back in order to understand what was going on, 'Novelty and attractiveness' were cited in one response as an important driver for the uptake of CAA at the level on the individual academic, whilst another cited 'Its new and interesting' in response to the same question. These *in vivo* categories looked like characteristics of enthusiasts. On reflection it became apparent that they were describing much the same thing, which might be abstracted as the attraction of spending time with new technology. The context of these remarks was re-examined and the concepts were merged under the new name 'Attraction of new technology' and subsequently under 'Innovator or early adopter' according to Moore's (1999) classification of technology adopters.

This kind of approach was taken throughout the coding scheme with the result that more than 500 nodes were reduced to fewer than 400. It was found that coding became considerably more efficient after rationalising the coding scheme in this way: it resulted in an approximate halving of the average time required to code a response document.

Besides simplifying the open coding process, refining the coding scheme had the additional benefit of making it easier to make clear distinctions among the reduced number of high-level categories. One consequence of this was the decision to recognise the effect of existing policy and practice on the diffusion of innovation from institutional to individual academic and *vice-versa*. Therefore a new level of infrastructural support and practice factors was inserted between the obvious levels of institutional and individual.

5.7.5 EMERGENCE OF CONCENTRIC DRIVERS AND OBSTACLES

More transcripts were analysed, at which point a further consolidatory open coding pass was performed in order to simplify what had become a very extensive coding tree with more than 700 nodes. Further reflection on 2003 survey responses showed that the cultural factors most intimately associated with the decisions of tutors to use CAA or not ('intrinsic cultural factors') could in most cases be characterised as the personal attitudes and propensities of tutors. These could of course still be positive or negative towards the use of CAA, i.e. could work as drivers or obstacles. In a similar way, the operational factors most closely associated with tutors' decisions ('intrinsic operational factors') were recategorised as to do with their actual attributes, propensities and their existing experience of CAA. Together, these comprise the cultural and operational halves of an inner shell surrounding tutors decision making (Figure 34).

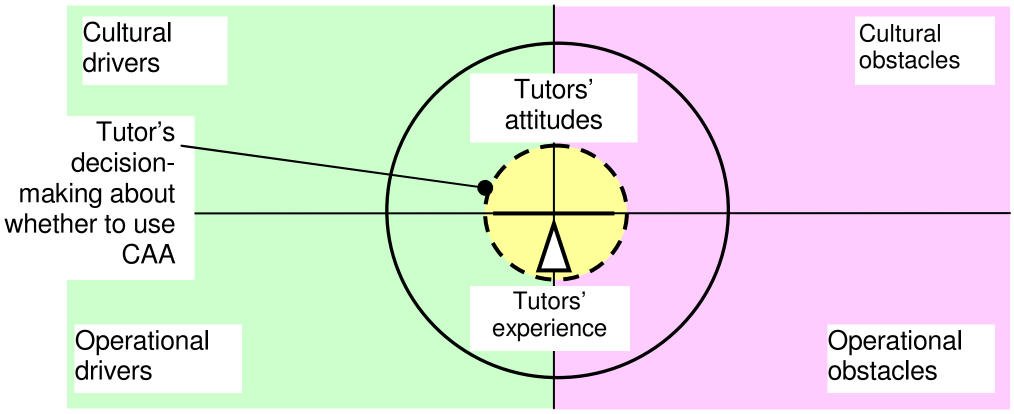

Figure 34- intrinsic factors recast as attitudes and implementation

At this point 'human factors' were integrated into the new 'infrastructure' shell. Infrastructure is clearly extrinsic to the tutor, although the analysis showed that it strongly influences tutors' decisions regarding CAA. A distinction was made between infrastructure in terms of learning and teaching practices and infrastructure considered as physical and technical environment. This was because tutors' experiences appeared to be directly influenced by physical infrastructure which includes technical support, whilst tutors' attitudes were largely conditioned by learning and teaching practices. These are represented here as a second shell surrounding the first (Figure 35).

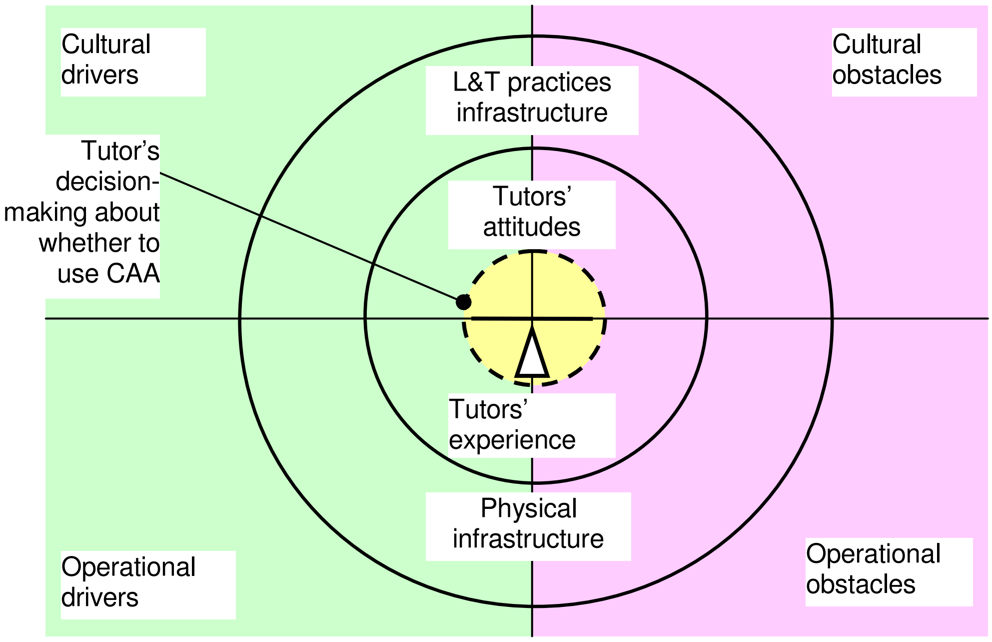

Figure 35- Human factors reinterpreted as Support and Resources

It became clear that in the cultural domain, support provision such as supplying time to develop CAA assessments is a resourcing issue controlled by policy at an institutional level. Equally, the operational resources available for implementing CAA are controlled by institutional policy and practices. Thus organisational policy and practice form a third layer around the first two (Figure 36). National and international policy and practice could form further shells beyond these.

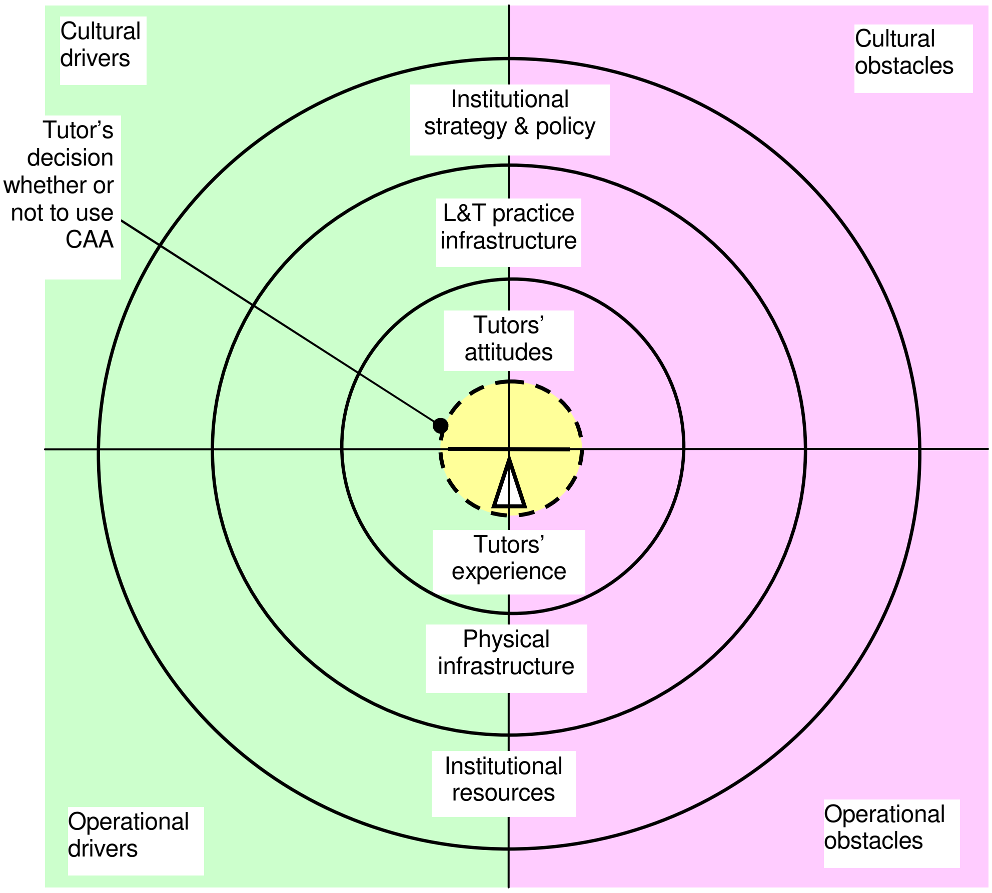

Figure 36- Influence of cultural and operational factors on decisions to use CAA

The emergence of this three-ply structure prompted a re-examination of the existing coding structure, during which it was found that many 'text units'[2] which had earlier been coded in the old scheme with misgivings fitted more naturally into the new three-ply structure. Existing drivers were more easily paired with more refined equivalent obstacles. Nearly 800 categories were recoded and condensed to just over 600.

Each coding pass resulted in a successive reduction in the number of changes made. Moreover, it became apparent that further reductions in the number of categories would be largely at the expense of hard-won richness and precision in coding. It was therefore felt this should be the last pass of the 2003 questionnaire responses and that the categories were at last becoming saturated, at least for this dataset (Glaser and Strauss, 1967; Strauss and Corbin, 1998a).

5.7.6 EXTERNAL VALIDITY OF PHASE 1 FINDINGS

To recapitulate, the phase 1 analysis raised two issues. Firstly to what extent was the emergent theory of CAA uptake developed from the perceptions of a small number of learning

[2] A 'text unit' is the unit of coding in QSR Nvivo

technologists in phase 1 supported by the wider CAA community? Secondly, did different stakeholder groups have common perceptions of obstacles and drivers referred to by the CAA expert project learning technologists in phase 1?

The question of differences in the perceptions of stakeholder groups was judged to require more data and was addressed after all the phase 2 data had been collected (sections 5.9.3 and 5.9.4). Regarding the triangulation of phase 1 data with the wider community of learning technologists surveyed in phase 2, *NVivo's* Assay tool was used to compare the perceptions recorded in interviews with CAA expert learning technologists and the questionnaire responses of learning technologists received in the 2003 survey by questionnaire. It should be noted that the weighting of responses is likely to vary between the two samples because one used semi-structured interviews where respondents were free to dwell on what they saw as key factors, whilst the other sample was taken from more structured free-text responses where repetition was unlikely. Nevertheless, it was taken as axiomatic that the number and proportion of references is an indication of relative factor importance (Glaser and Strauss, 1967; Strauss and Corbin, 1990; Strauss and Corbin, 1998a).

Considering only six CAA expert learning technologists were interviewed, there appeared to be a reasonable degree of harmony with the factors identified in questionnaire returns from 41 learning technologists in the self-selected UK sample (Table 34 where 'I' indicates Learning technologists in 2002 interviews and 'Q' indicates learning technologists in 2003/4 questionnaire responses).

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Agreement between LTs in phase 1 interviews and phase 2 questionnaires							
		Critical factor cited as a driver	**I**	**Q**	**Q**	**I**	**Critical factor cited as an obstacle**
Institutional	*Strategy*	Drive for online learning - MLEs, VLEs	3	7	17	15	Inertia, Conservatism, Inflexibility
		Informed top-down commitment	3	26	9	1	Naive uncommitted attitudes
		Clear inst. L&T strategy inc. QA of CAA	1	28	7	1	No clear institutional strategy
		Pressures for greater productivity	3	3			
		Effective strategy to manage change	1	2	17	-	Poor strategy to manage change
		Totals	**11**	**66**	**50**	**17**	
	Resourcing	Well-resourced Support & Training	1	33	8	2	Lack of Support & Training
		Allowing time to develop CAA	3	22	23	10	No allowance of time to develop CAA
		Secure central financial resources	2	31	25	11	Insecure/fragmented/financial resources
					6	2	No credit given for CAA initiatives
		Totals	**9**	**86**	**62**	**23**	
Infrastructure	*L&T practices*	Proven cost/benefit gains	5	108	26	-	Unproven cost-benefit gains
		Learning technologist support for CAA	4	41	1		
		Effective CAA Best Practice guide	26	41	8	2	Unaddressed CAA Practice issues
		Complexity appreciated & managed	7	8	5	1	Complexity unappreciated/unmanaged
		Teamwork in creating / reviewing tests	4	24	8	1	Tutors work in isolation
		Encouragement from champions	2	15	9	1	Influential, vociferous CAA critics
		Enthusiastic students	-	19	2	-	Unenthusiastic student community
		Access to subject-specific exemplars	-	2	2	1	No subject-specific exemplars
		Pedagogic gains	-	1	-	1	Limitations of objective items
		Totals	**48**	**261**	**61**	**6**	
	Physical structure	Flexible, fit for purpose CAA system	1	17	21	21	Inflexible shrink-wrap CAA system
		Secure centrally supported CAA service	3	15	11	6	Fragmented/insecure/unsupported sys
		Adequate N/W & W/S infrastructure	3	32	29	2	Inadequate NW & WS infrastructure
		Easily used CAA system	4	22	31	6	CAA system difficult to use
		Stable, reliable, resilient CAA system	1	15	35	5	Unstable unreliable fragile system
		Effective interoperability	-	3			
		Accessible to all students	-	1	1	1	Failure to make system accessible
		Totals	**12**	**105**	**128**	**41**	
Individual tutors'	*Attitudes*	CAA drives pedagogic development	6	19	5	14	CAA intrinsically unfit for use in HE
		Realistic expectations of CAA	1	7	2	-	Unrealistic expectations of CAA
		Tutors' traditional autonomy unthreatened	1	-	-	-	Tutors' traditional autonomy threatened
		Totals	**8**	**26**	**5**	**14**	
	Experience	Are innovators and early adopters	3	13	1	2	Conscripted tutors
		Have gained required IT skills	4	11	21	2	Technophobia, computer anxiety
		Have good grasp of assessment	1	13	18	2	Gaps in pedagogical skills
		Have had good experience of CAA	-	2	1	-	Have had poor experience of CAA
		Totals	**8**	**39**	**41**	**6**	
		Grand totals	***93***	***581***	***349***	***110***	

Table 34- Factors cited as drivers and obstacles by LTs in 2002 and 2003/4

No evidence was found that contradicted the emergent theory of CAA uptake developed in Phase 1. The 2003/4 surveys by questionnaire provided more detail about the drivers and obstacles underlying CAA uptake, but said relatively little about the interplay between them. Accordingly, plans were made to address these gaps in the emergent theory by asking questions about mechanisms of uptake in the phase 2 interviews and this theme was pursued later in the final (phase 3) interviews.

Taking the phase 1 interviews in aggregate with the phase 2 questionnaire returns, a total of nearly 2400 discrete citations ('text units') coded a total of more than 700 distinct factors which were for convenience collected under hierarchical headings as obstacles or drivers. In terms purely of the number of citations made, it appeared that the 2003/4 questionnaire respondents were most concerned about infrastructural influences on CAA uptake which meant cultural elements such as learning and teaching practice on one hand and physical infrastructure on the other (51% of all citations), followed by the innermost shell (experience and propensities of tutors with their hopes and fears) with 27% of citations. Institutional strategic policy and resourcing factors that are under the control of senior management (22% of citations) came third.

The distinction which had emerged earlier between cultural and physical factors was maintained at all three levels. The total number of cultural citations made at institutional strategy level, learning and teaching practice and tutors' attitudes are shown as lighter shades and in the same way, the total number of operational citations of institutional resources, physical infrastructure and tutors' experience are shown as darker shades (Figure 37).

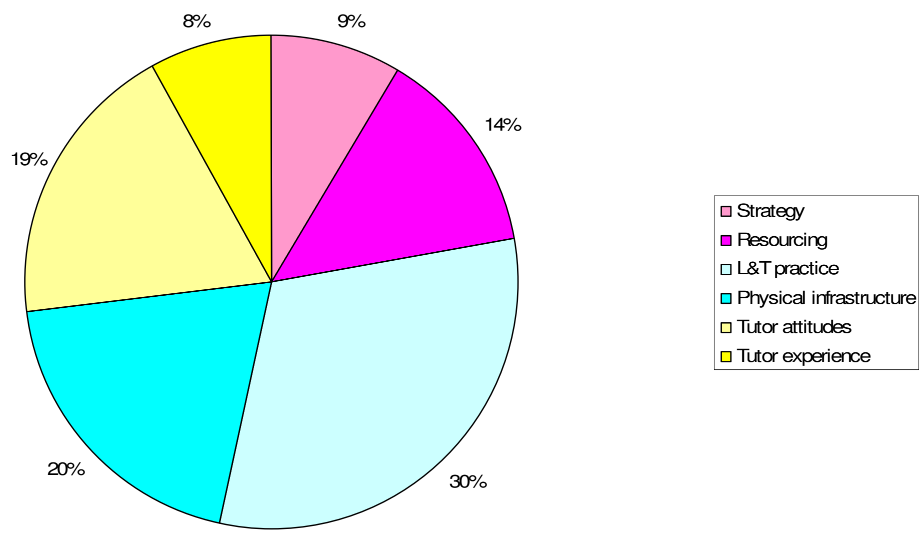


Figure 37- 2004 questionnaire critical factors by level and cultural/operational split

It can be seen that cultural factors were cited more frequently than operational factors (darker shades) at the infrastructural and individual tutor level (3:2 and 5:2 respectively), but that in contrast, citations of operational factors (especially resourcing) outweighed cultural factors at institutional strategic policy and resourcing levels by a factor of 3:2.

5.7.7 PRINCIPLE CULTURAL DRIVERS IN PHASE 2 QUESTIONNAIRES

Principle cultural drivers at the strategic level

The most widely cited cultural factors at the strategic level were *top-down long-term commitment* and having an effective learning and teaching strategy in place which accounted for 70 and 54 citations respectively out of a total of 201 cultural strategic citations.

Principle cultural drivers at the infrastructural level

The most frequently cited cultural drivers at the infrastructural level was *being able to demonstrate tangible cost benefit gains from CAA use* with 326 citations out of 736. Respondents were in broad agreement that being able to demonstrate real savings and/or real benefits are a powerful incentive for both institutions and individual tutors. It was also apparent that being able to demonstrate cost/benefit improvements is one of the most difficult things to do:

> "Institutions believe/hope there will be overall time savings. This is not likely." (AmO4M001)
>
> 'Savings are not readily quantifiable (releasing staff time to do what?)' (AmO4F001)

Principle cultural drivers at the level of individual tutors

Closer analysis showed that tutors and learning technologists regarded tutors having *broad confidence in CAA* (which included *the potential for CAA to drive pedagogic development*) was of key importance, accounting for 397 out of 451 citations of cultural factors at the level of individual tutors (Table 34Table 1). This factor had already emerged from context (during open coding) as something that is most readily demonstrable at the intermediate level of learning and teaching infrastructure, although it was frequently cited as a driver for both institutions and individual tutors.

5.7.8 PRINCIPLE OPERATIONAL DRIVERS IN PHASE 2 QUESTIONNAIRES

Principle operational drivers at the strategic level

The three most important operational drivers appeared to be the resources committed by the institution at the strategic level to *support and training* (57 citations), *allowance of time to develop CAA* (51 citations) and *secure central financial resources* (50 citations). In fact just these three strategic factors together accounted for nearly a third (30%) of all citations of operational factors.

Principle operational drivers at the infrastructural level

Almost as frequently cited were a set of five operational drivers at the infrastructure level. A *flexible, fit for purpose CAA system* (45 citations) was mostly cited in terms of its absence being an obstacle, whilst the of a *secure centrally supported CAA service* (45 citations) was mostly cited in terms of its provision being a driver. Adequate network and workstation infrastructure (28 citations) was widely cited as a driver and ease of use was referred to 26 times. However, a *stable, reliable, resilient CAA system* (16 citations) was principally seen in terms of its' absence being an obstacle. These five infrastructural issues were categorised as characteristics of CAA systems and made up another third (31%) of all operational citations.

Principle operational drivers at the level of individual tutors

A core concept that emerged from the data is that tutors are principally interested in using CAA to the extent that they believe its use can make them more capable in terms of productivity and pedagogic effectiveness. In other words tutors appear to be driven by hard-nosed assessments of 'what's in it for them' in terms of demonstrable returns. Tutor responses revealed an unromantic worldview where the real constraints of time and resources on CAA development must be addressed 'up front' before they can justify committing their own resources.

5.8 Open coding of phase 2 interview responses

5.8.1 THEORETICAL SAMPLING AND CHOICE OF INTERVIEW QUESTIONS

A number of unanswered questions and apparent gaps in the emergent theory arose during this stage of the analysis. In particular, there appeared to be some interesting differences in the perceptions of learning technologists who manage and support CAA systems and the tutors who use them. The next stage of data collection was a set of semi-structured interviews with CAA-using tutors (n= 7) and towards the end of the phase 2 data collection process a small and targeted set of interviews was undertaken with learning technologists (n=4). The aim was to probe in greater detail the relationships between tutors who are at the heart of the uptake process and the learning technologists who support them (Warburton and Conole, 2003a).

5.8.2 OPEN CODING OF 2003 TUTOR INTERVIEW TRANSCRIPTS

Some new open codes emerged from the 2003 interviews with tutors and some passages in the transcripts forced a re-alignment of existing axial coding. More than 50 additional codes were added to the 500 which emerged from phase 1 and the 2003 online questionnaire responses. New codes either described new aspects of relationships between tutors and other stakeholders, or illuminated features of uptake which had already been discovered.

One of the categories identified in phase 1 is tutors' decision-making about whether to use CAA, which has a consequence of *how* tutors use it. Causal conditions are the attitudinal and operational factors at the level of individual tutors. These are conditioned by intervening conditions at the level of the institution, by external operational drivers and by human factors. These are shown in the cloverleaf model of CAA uptake dynamics that was developed during the first phase of analysis, modified to take account of the threefold distinction made between attitudes, human factors and strategic factors regarding cultural obstacles and drivers (Figure 38). In this enhanced model, the intervening conditions of *institutional strategic drivers* and *institutional strategic obstacles* are in bold outline to distinguish them from the phase 1 model.

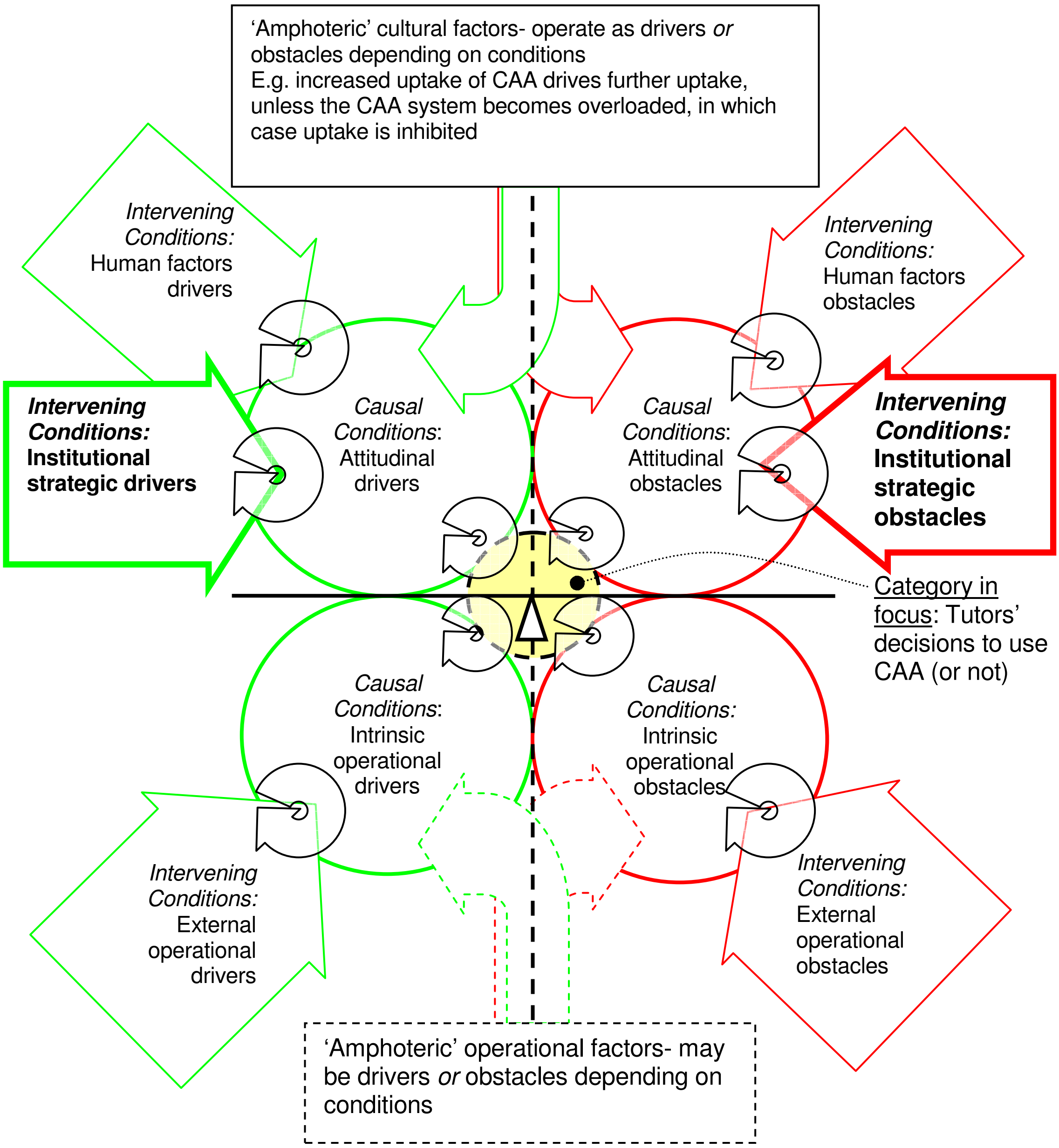


Figure 38- 'Cloverleaf' model refined to accommodate 2003 questionnaire responses

Although the refined cloverleaf model depicted above was more sophisticated, it was judged deficient in failing to make fully visible the interplay of all the drivers and obstacles with the various stakeholders. This was perhaps unsurprising bearing in mind the questionnaire's primary focus on the factors promoting or restricting CAA uptake rather than, for instance, how the various factors interacted with the different stakeholders.

Despite this, many respondents went beyond simply naming what they saw as the individual factors and tried to construct a kind of narrative. Some respondents went further still by volunteering prescriptions for addressing perceived obstacles and thus increasing the uptake of CAA:

> CAA works best when an enthusiast is driving the process. This was true when we first introduced the use of MCQ in the mid-sixties, although technology was not really involved at that time (answers were coded manually onto punched cards by typists for computer entry). Now, it still works best with an enthusiast who is also confident in adopting new technologies - an 'early adopter'. (Tutor AmO5F001)

5.8.3 OPEN CODING OF 2004 LEARNING TECHNOLOGIST INTERVIEW TRANSCRIPTS

The coding was performed in the same NVivo project used in the earlier phases, but initially a distinct coding tree was used in order to avoid 'contaminating' the discursive utterances in the interviews with the more structured data from the survey responses. However, it was found that the themes which emerged during open coding had so much in common with the original scheme that it seemed unhelpful to maintain a separate scheme and the two were merged during a late iteration of the open coding process.

5.9 Axial coding - refining the model of uptake

It may be recalled that Strauss and Corbin defined axial coding as

> … the process of relating categories to their subcategories, termed 'axial' because coding occurs around the axis of a category linking categories at the level of properties and dimensions. (Strauss and Corbin, 1998a p. 123)

The process of axial coding signals the beginning of the synthetic part of GT where data is put back together from the component concepts it was fractured into during open coding.

5.9.1 RECAPITULATION OF PHASE 1 MODEL OF CAA UPTAKE

It may be recalled that the emergent model of CAA uptake that was developed from the phase 1 interviews centred on tutors' in-built susceptibilities to incentives and disincentives for the use of CAA. These intrinsic predispositions strongly influenced tutors' decisions about whether to use CAA or not, but were also influenced by infrastructural factors. Beyond this, institutional factors acted as more remote drivers and obstacles.

In other words, tutors were naturally inclined to use CAA if they were comfortable with ICT and saw pedagogical or productivity benefits: these were modelled as intrinsic cultural drivers. It was also natural for tutors to prefer CAA systems that were easy to use, secure and which preserved their investments: these were modelled in phase 1 as intrinsic operational drivers. Conversely, other tutors were naturally averse to technology-based solutions, especially if they were not seen to be pedagogically fit for purpose, or were perceived to be insecure or which did not seem to scale well: these were considered to be intrinsic cultural obstacles and were the opposites of intrinsic cultural drivers. Tutors' legitimate concerns regarding operational factors such as actual (or second-hand) experience of the technology failing in some way were conceptualised as intrinsic operational obstacles that are the opposite poles of intrinsic operational drivers.

According to Lewin's (1958) 'freeze' model, in order to increase the uptake of CAA, attempts may be made to influence the perceptions of tutors so that inclinations are strengthened and disinclinations are weakened.   Intrinsic cultural obstacles were addressed by training interventions and intrinsic organisational obstacles were weakened by risk mitigating procedures.   In cultural terms, it also appeared that institutional pressures for more productivity acted as drivers through the cultural measures taken by institutions (top left quadrant) whilst institutional pressures to contain costs acted as obstacles by acting on existing concerns about the effectiveness of CAA (top right quadrant). In operational terms, CAA systems could become overloaded which acted as an obstacle by reinforcing fears of CAA going wrong at a critical time such as the delivery of a large high-stakes assessment (bottom right quadrant). There was some evidence that such systems can become 'victims of their own success' by attracting users in such unexpectedly large numbers that rather than driving up uptake still further by word of mouth recommendation, this suddenly became an effective obstacle (bottom left quadrant). The term 'amphoteric' was applied to this observed change in operation of increased uptake which would under normal conditions be considered as an unambiguous driver for increased uptake (Figure 39).

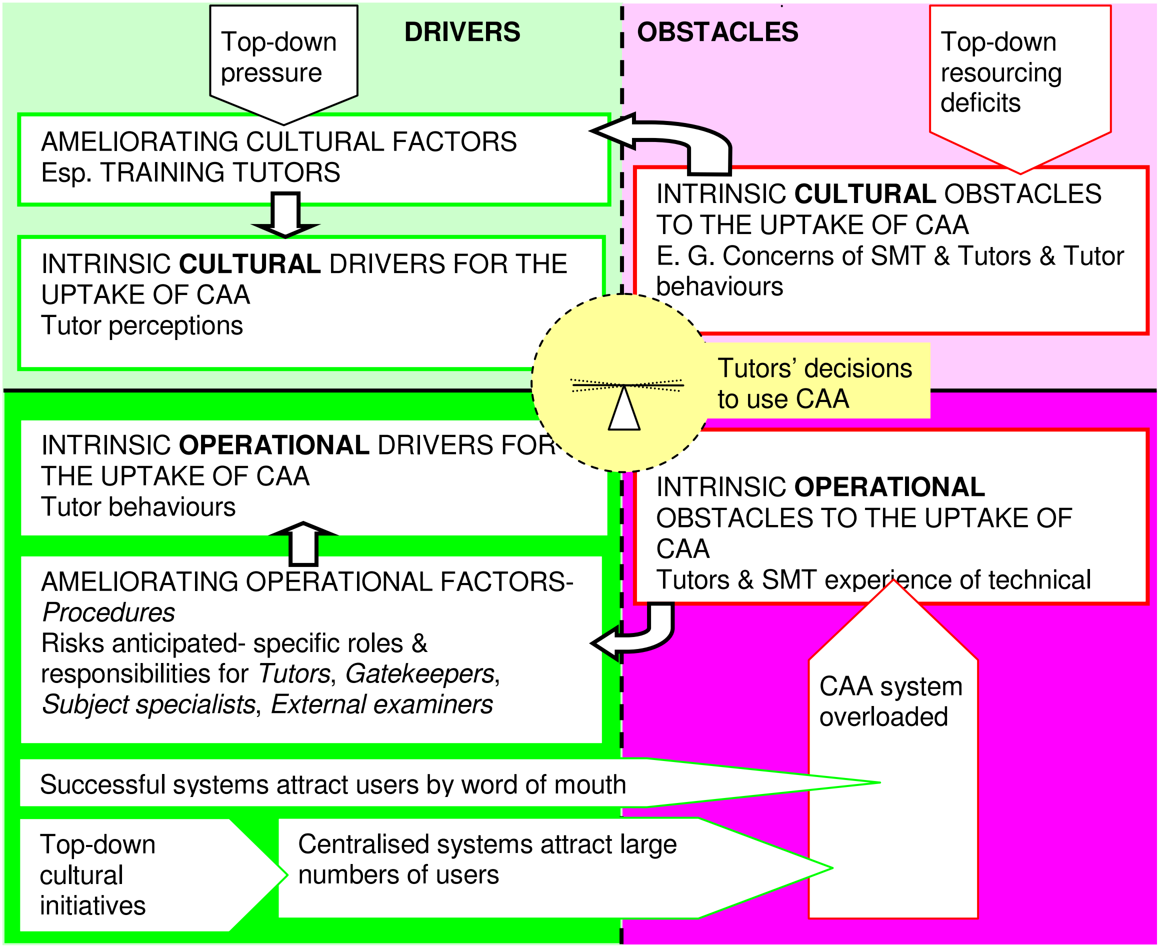


Figure 39- Condensed phase 1 model of CAA uptake

The gaps identified in the emergent theory that were to be addressed in phase 2 were:

1. Which are the *key* factors influencing tutors' decisions regarding CAA use?
2. To what extent do the perceptions of stakeholders vary?
3. To what extent is the balance of drivers and obstacles static or dynamic - how are tutors susceptible to persuasion or discouragement?
4. Related to (3) is what, if any, other *cultural* or *operational* factors are 'amphoteric'?

A record was made of the integrative diagram maintained during open coding (Figure 40). This enhanced model is a more detailed version of the model developed in phase 1 axial coding (Figure 39) but lacks the paradigm links between the factors (developed during axial coding). It is essentially the three-core concentric model of strategic, infrastructural and individual practice divided into four quartiles according to whether factors work as drivers or obstacles in the cultural or operational domain. Tutors' decisions about whether (and how) to use CAA were at the core of the model because this is intimately bound up with tutors' intrinsic and conditioned inclinations.

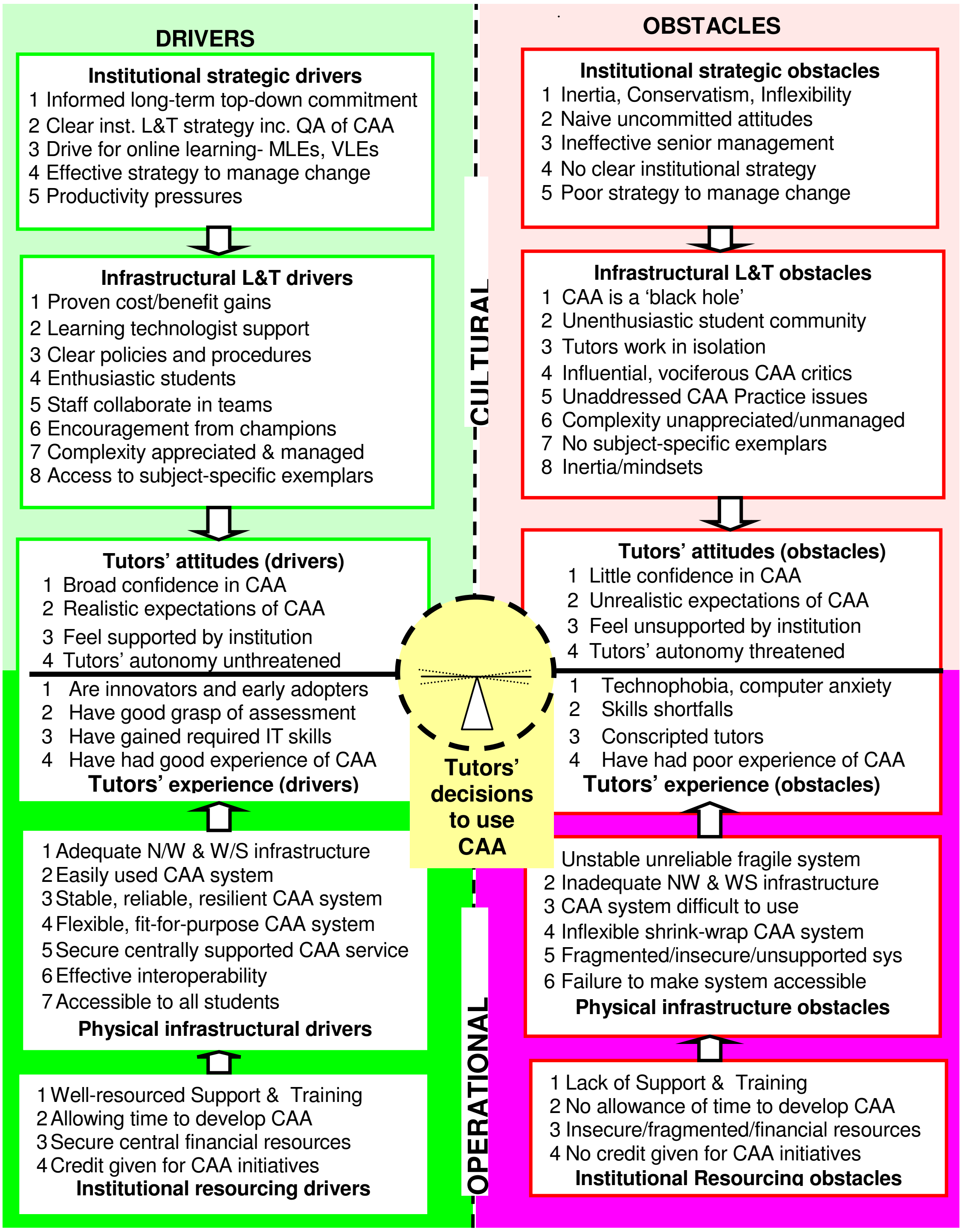


Figure 40- Factors affecting CAA uptake based on 2003/4 questionnaire responses

Infrastructural factors emerged as acting directly on tutors and strategic factors emerged as acting indirectly upon tutors via the infrastructure. The notion of 'intrinsic' obstacles and drivers is preserved in *tutors' experience* and *tutors' attitudes* which act directly at the most fundamental and personal level to influence the decision of whether to use CAA and if so then to what extent it should be used. However, physical infrastructural factors such as ease of use and resilience of the CAA system have been teased out from the inner shell of tutors' perceptions and placed in the operational domain in an intermediate infrastructure layer. In the same way, some factors such as how well CAA *complexity [is] appreciated and managed* emerged during analysis as more relevant to the infrastructure of learning and teaching practice and have therefore been abstracted from the central level of tutors' perceptions and placed in the cultural domain of the intermediate infrastructure shell.

5.9.2 A MINI-FRAMEWORK FOR PHASE 2 AXIAL CODING

The phase 1 analysis prompted the question of which factors influencing tutors' decisions regarding CAA use are most important (Figure 41).

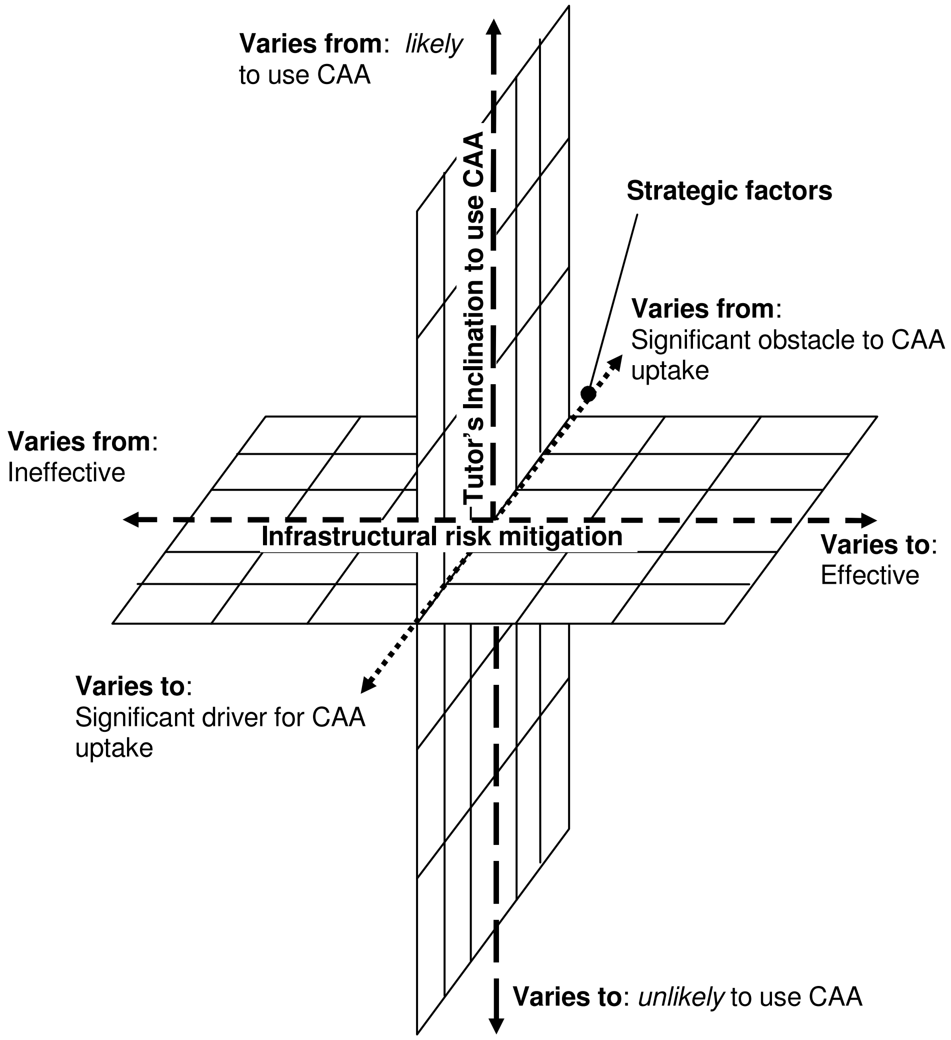


Figure 41- Initial phase 2 mini-framework

The three principle categories shown mutually perpendicular in bold, each with sub-categories indicated by parallel lines which form planes. The cross-cutting of other categories and sub-categories is indicated by the gridded arrangement of each plane. Thus the central core of tutors' *experience and attitudes* that most intimately influence their decisions to use CAA can be mapped directly to the *tutor's inclination to use CAA* plane in the mini-framework developed earlier in phase 1 (Figure 41).

5.9.3 THE PERCEPTIONS OF DIFFERENT STAKEHOLDER GROUPS

The second question raised by the phase 1 analysis was the extent to which the perceptions of stakeholders (senior management, tutors and learning technologists) vary. The 2003/4 questionnaire responses were from tutors and learning technologists in roughly equal proportions. The number of citations for each emergent category comparison had been compared earlier (Figure 37). Both groups had much to say about the attitudes and reactions of senior management, so it was possible to include all three in the phase 2 analysis, with the caveat that since senior managers had not been represented in the respondents it was important to validate the emergent model with senior managers in phase 3.

It should be borne in mind that no responses were received from senior management (SMT) or quality assurance (QA) staff (although an attempt was made to test the emergent theory with SMT and QA staff during phase 3 data collection). In accordance with the 'analysis through comparison' technique advocated by Strauss and Corbin in their discussion of analytic tools (1998a pp. 93-97), comparisons were made between different groups of stakeholders (Figure 42):

(i) Job function (learning technologists vs. tutors)

(ii) Institution type (tutors in old vs. new universities)

(iii) Subject type in terms of susceptibility to objective testing (maths-based vs. discursive). Tutors had been grouped as specialists in humanities, social science and the mathematically-based sciences.

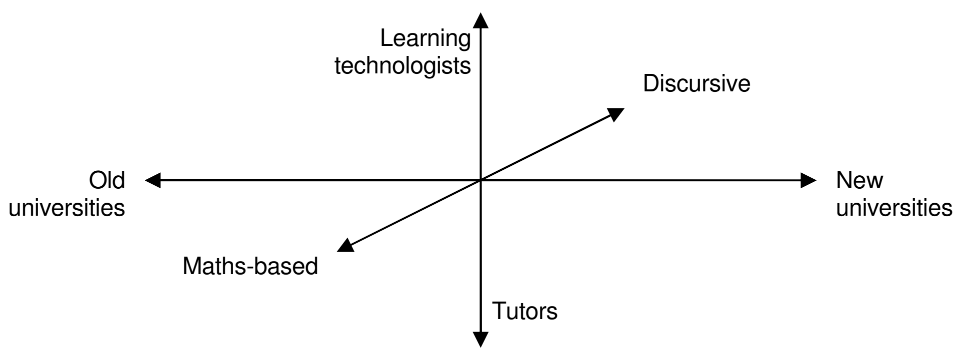


Figure 42- Comparisons in terms of subject type, job function and institution type

Imbalances in citation frequencies were used to identify differences in relative perceptions between the compared groups.

5.9.4 COMPARISONS BETWEEN LEARNING TECHNOLOGISTS AND TUTORS

The numbers of category citations made by learning technologists and tutors in phase 2 questionnaire responses are tabulated separately in order to facilitate comparisons between them. The number of citations were counted separately as obstacles when absent and as drivers when present (Table 35).

		Critical factors cited by tutors and LTs in 2003/4 questionnaire responses	As a driver when present		As an obstacle when absent	
			Tutors	LT	LT	Tutors
Institutional	Strategy	Strategy to manage change	3	2	3	2
		Productivity pressures	2	3	14	12
		Drive for online learning	2	7	17	13
		L&T strategy inc. QA of CAA	12	28	7	7
		Top-down long-term commitment	17	26	9	18
		Total strategy citations	**36**	**66**	**50**	**52**
	Resourcing	Credit given for CAA initiatives	0	0	6	6
		Well-resourced Support & Training	37	33	8	16
		Secure central financial resources	21	31	25	29
		Allowing time to develop CAA	31	22	23	40
		Total resource citations	**89**	**86**	**62**	**91**
Infrastructure	L&T practices	Access to subject-specific exemplars	10	2	2	2
		Complexity appreciated & managed	6	8	5	2
		Encouragement from champions	4	15	9	14
		Staff collaborate in teams	12	24	8	15
		Enthusiastic students	26	19	2	32
		Clear policies & procedures	13	41	8	21
		Learning technologist support	57	41	1	1
		Proven cost/benefit efficiency gains	126	108	26	66
		Total learning and teaching citations	**260**	**261**	**61**	**154**
	Physical structure	Accessible to all students	1	1	1	0
		Effective interoperability	1	3	0	0
		Secure centrally supported CAA sys	13	15	11	14
		Flexible, fit for purpose CAA system	18	17	21	14
		Robust centralised system	28	15	35	32
		Easily used CAA system	36	22	31	21
		Adequate N/W & W/S infrastructure	37	32	29	26
		Total physical infrastructure citations	**134**	**105**	**128**	**107**
Individual tutors'	Attitudes	Tutors' autonomy respected	0	0	0	1
		Realistic expectations	12	8	2	3
		Feel supported by institution	6	7	6	9
		Broad confidence in CAA	152	103	75	67
		Total tutor attitude citations	**170**	**118**	**83**	**80**
	Experience	Have had good experience of CAA	7	2	1	0
		Are innovators and early adopters	22	13	1	4
		Have good grasp of assessment	15	13	18	17
		Have gained required IT skills	13	11	21	32
		Total tutor experience citations	**57**	**39**	**41**	**53**
		Grand totals	***746***	***673***	***425***	***537***

Table 35- Citations of drivers and obstacles in 2003/4 questionnaire responses

Although tutors and learning technologists broadly agreed on the relative importance of many drivers and obstacles, significant differences in their perspectives emerged. These differences are described in order beginning with the highest strategic level and working down to the level of differences in individual tutors practice.

Bearing in mind that a little less than half of all 2003/2004 questionnaire respondents were learning technologists, it seemed clear that at the strategic level they saw the *drive for centralised systems* such as MLEs as a driver for uptake, whereas both constituencies agreed that *inertia* at various levels was an important obstacle. Learning technologists were much more concerned than tutors about the importance of *informed top-down commitment.* Tutors and learning technologists agreed on the importance of well resourced support and training as important drivers. Secure financial resourcing was cited by both as an important driver and allowing time was agreed to be important as both a driver and, where absent, an obstacle. At the infrastructural level, learning technologists seemed to put more emphasis on proven cost/benefits gains than tutors did and volunteered the importance of effective 'best practice' guides whereas tutors mentioned 'best practice' guides much less. There were few obvious differences between tutors and learning technologists at the level of individual practice.

Institutional strategies

Firstly, some differences at the strategic level are described. The institutional strategic factor *drive for online learning* included the importance of MLEs and VLEs as catalysts but was cited only twice as a driver by tutors, whereas learning technologists cited it seven times. The negative aspect of this factor (inertia, conservatism and inflexibility) was heavily cited as an obstacle both by learning technologists and tutors. The presence of a clear learning and teaching strategy which included quality assurance (QA) of CAA was equally often cited as a driver by learning technologists and tutors as was top-down long-term commitment, although tutors cited its negative aspect (which emerged from alleged naïve uncommitted attitudes on the part of senior management) twice as often as learning technologists. There were few citations of *productivity pressures* although both learning technologists and tutors frequently cited *ineffective senor management* as a counterpoint to *productivity pressures.*

Resources at the strategic level

Secondly, learning technologists and tutors differed little in their perceptions of the relative importance of the way resources are administered at the strategic level. It was noteworthy that both groups made repeated citations of the importance of well resourced support and training as a driver for the uptake of CAA, although tutors cited its absence as an obstacle twice as often as learning technologists and both groups together cited the absence of support and training a third as frequently as they cited its importance as a driver. This may be a case of 'what one never had one never misses', in other words that the respondents who are not citing a lack of support and training as an important obstacle do so because they never had it in the first place. In contrast, respondents who see its presence as an important driver may be reacting to positive experiences had with well-resourced schemes.

Allowing time to develop CAA and *secure financial resources* were both cited as drivers (when present) and obstacles (when absent) equally frequently by both learning technologists and tutors, but a lack of *credit given for CAA initiatives* was cited only as an obstacle by equally small numbers of tutors and learning technologists. The complete absence of its citation as a driver may indicate that little regard is being given to encourage tutors who are developing innovative assessment modes and that its low management profile is also regarded as a powerful disincentive by tutors who invest in CAA.

Cultural infrastructure: learning and teaching practices

Thirdly, at the infrastructural level, the cultural domain of learning and teaching practices showed more differences in the outlooks of the two groups. The importance of *proven cost/benefit and efficiency gains* was the second most frequently cited factor in the phase 2 questionnaire data (326 citations). Tutors referred to its absence as an obstacle to uptake more than twice as frequently as learning technologists and this appeared to be at least partly due to tutors being sensitive to productivity pressures and the need to demonstrate clearly the worth of their investment in CAA. The implementation of *learning technologist support* was seen by both groups as a significant driver for CAA uptake, which harmonised with the importance of resourcing it properly.

The existence of *clear policies and procedures* for the use of CAA was cited as a driver more than twice as often by learning technologists than tutors and their absence was cited as an obstacle three times more frequently by learning technologists than tutors. A related issue was the ability of learning technologists to *manage the complexity of CAA* which showed a small difference between the two groups where tutors cited it half as often as learning technologists, either as an obstacle in its absence or as a driver when present. These findings may reflect the investment made by learning technologists in the creation, maintenance and promulgation of CAA policies and procedures whilst tutors may find them onerous.

The importance of *staff collaborating in teams* to creating and reviewing tests and the importance of *encouragement from [CAA] champions* were mentioned twice as often by learning technologists compared with tutors. These findings support the notion that learning technologists are more concerned with implementing measures that promote CAA uptake than tutors.

Having a community of enthusiastic students was cited frequently by tutors both as a driver when present and as an obstacle when absent, whilst learning technologists differed in hardly mentioning it as a driver, although they cited it as an obstacle almost as frequently as the tutors did. This might be expected from the more student facing nature of tutors' roles and a widely reported increase in the importance of student feedback (THES, 2005b). *Access to subject-specific exemplars* of CAA practice was cited as a driver by tutors much more frequently than by learning technologists which is understandable bearing in mind the pressures on tutors to produce fit for purpose assessment activities within a reasonable time.

Physical infrastructure

Fourthly, the operational area of physical infrastructure showed few differences in perspective between tutors and learning technologists. The biggest differences between concerned *easily used CAA systems* which was cited twice as often by tutors compared with learning technologists, both as a driver when present and an obstacle when absent. This is unsurprising considering that although tutors often feel they have insufficient time to specialise in CAA or familiarise themselves with the tools, they constitute one of the largest groups of CAA authoring and reporting tool end users.

Tutors' attitudes towards CAA

Fifthly, there were few obvious differences between the two tutors and learning technologists in terms of their reported perceptions of the effect tutors' attitudes have on the uptake of CAA. The importance of tutors having *broad confidence in CAA* was the most frequently cited factor in both groups and included notions of fitness for purpose.

Tutors CAA experience

Lastly were differences at the level of individual tutors' experience. Tutors being *innovators and early adopters* was often cited as a driver, predominantly by tutors, whilst its absence was seldom mentioned and then mostly by tutors. In a similar way, the importance of having *had good experience with CAA* was mentioned exclusively as a driver by tutors and very little by learning technologists. This may indicate that learning technologists were discounting the importance of tutors' enthusiasm or previous success, perhaps because part of their role was to support unenthusiastic tutors.

These differences were not tested for statistical significance because of the way the figures were obtained (for example one respondent might be responsible for a large number of citations) and the small samples size. However, these emergent differences in perspective between tutors and learning technologists made me wonder what caused them.

Differing priorities, differing trajectories

The mini-framework that had been developed during an earlier part of axial coding had the three major categories of strategic factors which presented obstacles or drivers at the institutional level, *risk mitigation* measures at the infrastructural level which were more or less effective in reducing risk and tutors' *inclinations to use CAA* which operated as obstacles or drivers at the individual level. A cross-cutting of categories led to an analysis of *risk mitigation* and *inclination to use CAA* at the level of their subcategories *priorities* and *trajectories* (Figure 43).

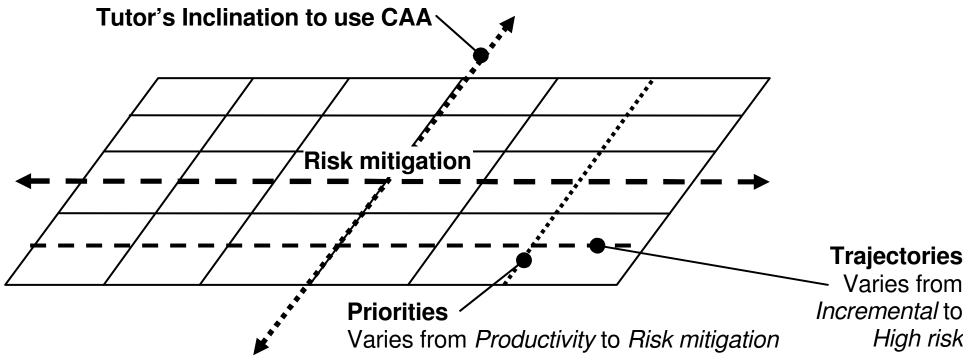


Figure 43- Cross-cutting Priorities and Trajectories

Learning technologists saw their role as maximising the benefits of learning technology whilst minimising its risks. They preferred a supported, prescriptive and staged model of uptake whereby small and easily managed increments of risk are incurred at each step:

> … if you had the perfect scenario, then you would do it bit by bit and make sure you are happy with it before moving on… [rather than] saying 'right we've just put it in, let's do 300 students without testing it first' (Learning technologist Lt2OM008)

It emerged that learning technologists advocate this style of uptake in order to establish a linear succession of assessment applications that begins at the planning stage and progresses through pilot, low stakes and high stakes testing. This arrangement of uptake stages is shown for the first time as the 'trajectory' model of uptake (Figure 44).

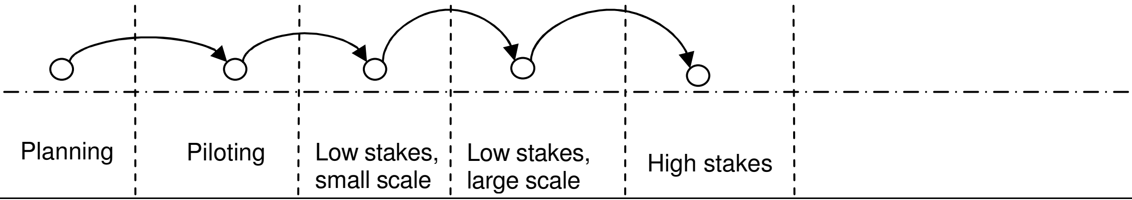


Figure 44- Trajectory model showing Incremental uptake by tutor

Institutions were said to take this sequence one stage further to an institutionally embedded state where the use of CAA is taken for granted (Figure 45).

> Well, a lot of [the success]…behind what we're doing is taking small-scale stuff and passing it to a sort of institutional implementation level where people don't think about it any more... (Learning technologist LtO3M003)

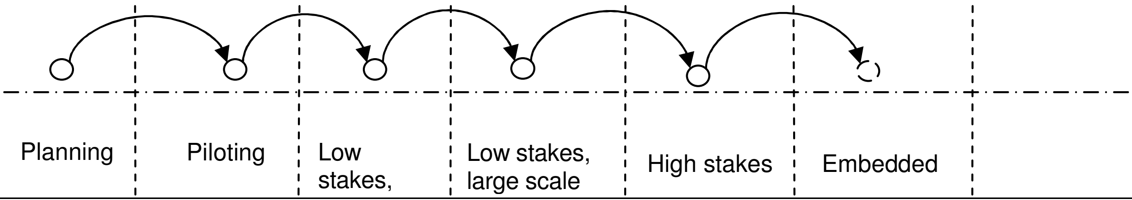


Figure 45- Trajectory model showing Incremental institutional uptake

This style of uptake required some degree of support at the departmental or institutional level and was sometimes described as a 'top-down' pattern. In contrast, tutors advocated a 'diffusion' model of uptake whereby enthusiasts led the way by providing examples of productivity gains or, less frequently, of pedagogic gains. This was referred to as 'bottom-up' uptake.

Ad hoc trajectories

Learning technologists and tutors agreed that most tutors were driven primarily by short-term goals in their teaching activities:

> …what most tutors here are concerned with is what they're doing in the here and now. The long term strategic plans for the university are quite often at odds with what people need to be doing in the short term… they feel crippled because their short-term requirements are not met. It's 'jam tomorrow'. (Learning technologist LtO5M006)

Learning technologists and tutors also agreed that tutors took on high levels of risk because of the need to get assessments into production with minimal preparation:

> So from an institutional viewpoint we are trying to get at the high risk aspect of things and what do they want… the quick returns, yes - and it's a balance. (Tutor AmN3M007)

> [tutors have] left it for the last minute and they demand that they have it straight away and they see it as our job to fulfil that demand. (Learning technologist Lt2OM008)

This pragmatic approach leads to an ad hoc style of uptake whereby the perceived productivity benefits of summative testing are secured at the expense of increased risk (Figure 46).

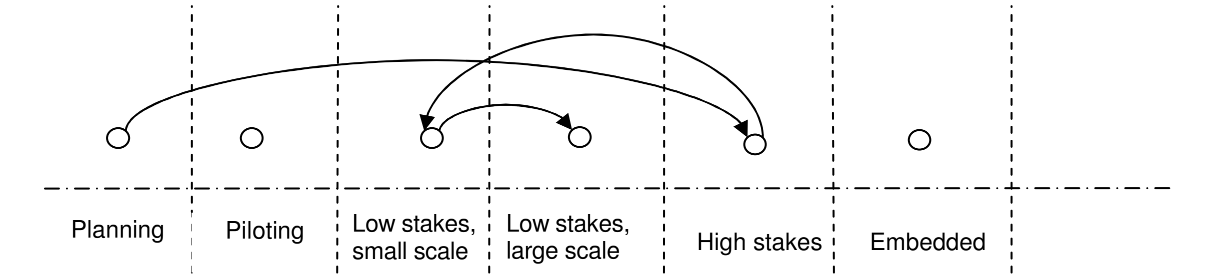


Figure 46- Trajectory model showing ad hoc tutor uptake

Disastrous trajectories

In extreme cases where the high levels of risk incurred with this approach result in a CAA failure, the consequences for further uptake are severe and long lasting. In particular, the transitions from small to large scale applications and from low to high stakes assessment both emerged as entailing significant shifts in the degree of risk taken on:

> [We put too much] trust [in]…pioneers, who develop wonderful systems that were never intended to be large-scale and try… to scale them up with disastrous results. (Learning technologist LTS3F001)

In the absence of sufficient risk mitigation, this can lead to a trajectory that goes from a (perhaps inadequate) planning stage to a high risk application that goes wrong publicly, resulting in the tutor and perhaps their colleagues abandoning CAA:

> …apparently the tutors apparently didn't know who to call…in the event it took them half an hour to find somebody, by which time the people who had furthest to travel had already left… that tutor will never use it again… (Learning technologist (Lt3OM005)

This can be seen as an extreme case of ad hoc uptake (Figure 47).

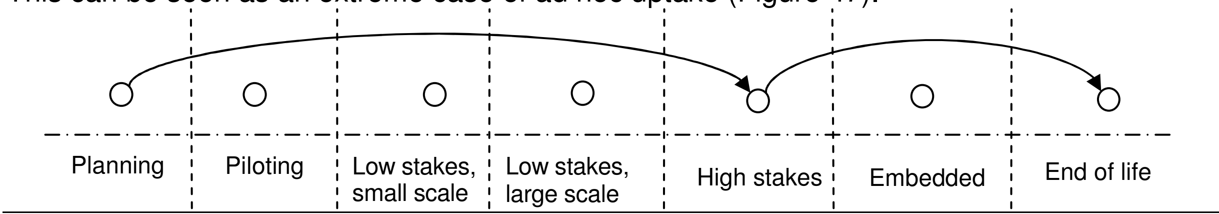


Figure 47- Trajectory model showing disastrous pattern of uptake

Cut short trajectories

Where tutors had developed a pattern of CAA use and were happy with the results, some respondents reported that usage sometimes stopped abruptly even though no CAA failures had occurred. This seemed counter-intuitive because developing a CAA application often requires a substantial investment in time and effort which raised the question of why should people go back to using traditional assessment activities when they have something that works. Further analysis showed this to be associated with a pedagogically-driven approach that was truncated by tutor turnover (Figure 48):

… well the CAA on this module was implemented by 'Harry' and he worked it up from formative to diagnostic and was going to look at summative but he's moved on now. The new guy knows nothing about CAA and has gone back to pencil and paper… (Tutor AhO3F09)

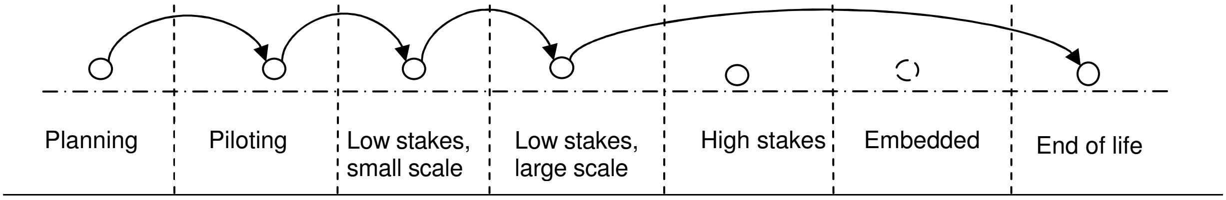


Figure 48- Trajectory model showing cut short pattern of uptake

5.9.5 INSTITUTIONAL TYPE AND CAA TRAJECTORIES

In attempting to test the existence of a link between institution type and CAA uptake, two of the relevant core categories of risk mitigation and strategic factors were compared at the level of their subcategories. This involved cross-cutting (analysing the relationships between) the subcategories *priorities* (a subcategory of risk mitigation) and the three subcategories *institution age*, *centralisation* and *research centredness* which are subcategories of strategic factors (Figure 49).

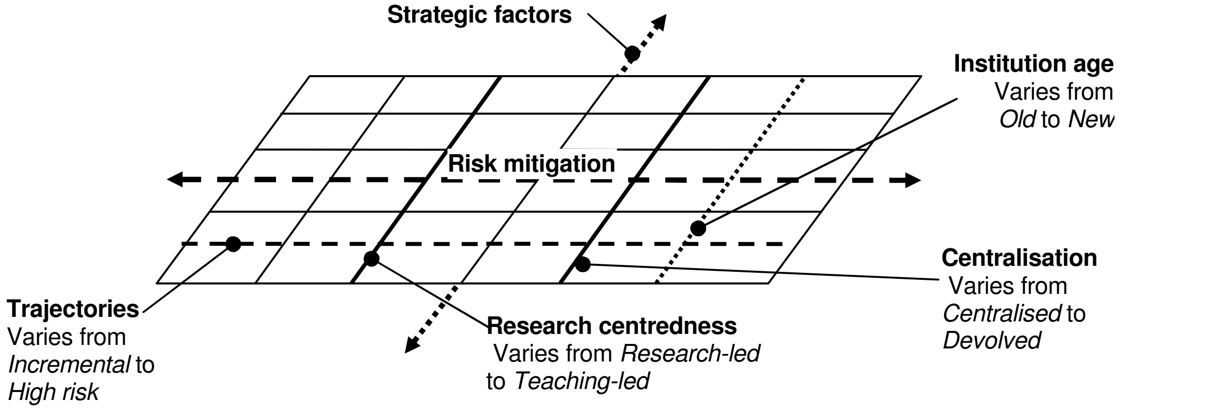


Figure 49- Cross-cutting Priorities and Institution type

Entanglement of institution types

Respondents were readily identified as members of associations such as the Russell Group (RG) which are almost by definition research led, as opposed to members of the Campaigning for Mainstream Universities (CMU) group which are widely regarded as teaching led. This made it possible to categorise their responses as coming from research-led or teaching-led perspectives. The same applied to the age of institutions.

However, it was more difficult to identify respondents' institutions as either centralised (associated by respondents with relatively low levels of *institutional inertia*) or devolved (relatively high levels of *institutional inertia*) because this dimension was seen much more as a continuum and respondents from the same institution sometimes differed about the extent of centralisation or devolution in their institutions, perhaps because universities are complex organisations that may devolve some aspects of their work whilst retaining a degree of central control over other aspects such as funding.

An analysis of responses revealed that respondents in research-led universities reported, when asked, that they worked in devolved institutions and when asked, respondents in teaching-led universities reported that they worked in centralised institutions. There appeared to be a link between the age of institutions, the degree of devolution and the degree of research centredness, although this is most unlikely to be a one-to-one map. This entanglement may constitute a confounding factor where the views of respondents in research-led institutions are difficult to distinguish from those of respondents located in devolved institutions or old universities and much the same applies to centralised and teaching-led institutions or new universities. Possible ways of resolving this entanglement are proposed in section 7.4.2.

Institutional inertia was more often cited by members of old, devolved or research led institutions as an effective obstacle to the uptake of CAA in the 2003/4 questionnaire responses and in interviews. The converse applied to universities categorised as new, centralised or teaching led where it was rarely mentioned.

5.9.6 UPTAKE IN OLD AND NEW UNIVERSITIES

The tension between research output and teaching

In old universities, tutors saw their primary function as producing the highest possible quality of research output (a total of 12 textual citations) with teaching as a subordinate activity. They spoke more about CAA as a time saver and emphasised summative applications.

In new universities, this general trend appeared to be reversed with tutors talking less about the next RAE (five textual citations) and emphasising pedagogic benefits above productivity benefits. CAA was more often seen as a tool for improving the quality of student learning.

It should be emphasised that these impressions were gained from a small number of largely self-selected tutors, many of whom were CAA enthusiasts. Although no quantitative validity applies to these conjectures, in qualitative terms a narrative has emerged which resonated with the experience of an expert group.

The total number of tutor respondents surveyed in old (n=52) and new universities (n=52) was equal. There was little difference in the male:female ratio (34:18 and 37:15 respectively) and average ages were similar (43 and 40 respectively).

Learning and teaching practice in old and new universities

It emerged that tutors in old universities were keenly aware of the need to produce research papers that score highly in the periodic UK research assessment exercise (RAE) and lack of time was frequently cited as an effective obstacle to the uptake of CAA in old universities. These time pressures on tutors militated against their learning to use awkward tools, particularly where CAA systems were used only occasionally for annual high-stakes assessment exercises:

> And you learn it once and put your test up; and you've lost your skill then because you've probably done it… and you always have to keep relearning it, if you only use it once a year… and I just don't have the time. (Tutor AmO5M009)

There only discernable difference at the level of learning and teaching practice between the citation frequencies of tutors in old and new universities was the perceived importance of productivity gains which was cited twice as often by tutors in old universities. This link is supported in qualitative terms by the strength of expressed sentiments:

> … the RAE has an awful lot to do with [the fact that] there's so much pressure on people here… It's become so important now, it's about money and jobs and so there's this massive pressure… (Tutor AsO5M006)
>
> 250 pieces of coursework marked instantly… saves marking test papers by hand… (Tutor AmO4F002)
>
> … it worked extremely well and got all the marks graded in about five minutes that evening and you know, it was [a] very nice - well, delightful experience. (Tutor AsO4F011)

5.9.7 SUBJECT-RELATED DIFFERENCES IN UPTAKE

The third aspect of differing perspectives on CAA uptake concerns subject-related differences. All questionnaire responses from tutors were coded according to whether they taught a subject that was mathematically based (so included a large base of less contested knowledge), a social science subject (a lesser degree of contested knowledge) or a humanity (smallest base of contested knowledge). A preliminary analysis of the responses revealed a high degree of similarity in the responses of most Social Science specialists and of humanities teachers, with the exception of economics specialists whose responses had more in common with mathematics-based specialists. In fact tutors and learning technologists spoke more in terms of 'discursive' and 'maths-based' subjects and in order to simplify the comparison, a decision was taken to aggregate Humanities and the more discursive Social Sciences. This merged group was then compared with teachers of mathematically-based subjects (Table 36).

Mathematically-based 'objective' subjects			Discursive 'subjective' subjects
Biology	Chemistry	Computer science	Humanities (inc. Modern Languages, the Arts etc.)
Economics	Engineering	Mathematics	Social sciences (inc. Law, Management science, Education, Social Work etc.)
Philosophy	Physics	Psychology	
Social statistics	Etc.		

Table 36- Distinguishing between maths-based and discursive subjects

Respondents who taught mathematically-based subjects (n=70) outweighed those who taught discursive subjects (n=34) by a ratio of two to one which was compensated for when comparing citation frequencies.

Subject type and risk mitigation

When looking for a link between subject type and CAA uptake, a productive comparison was made between *risk mitigation* and strategic factors were compared at the level of their subcategories. This involved cross-cutting *subject type* (a subcategory of *tutors' inclinations*) against relevant subcategories of the core category *risk mitigation* such as *learning technologist support*, *ease of use* and *stability of CAA system* (Figure 50).

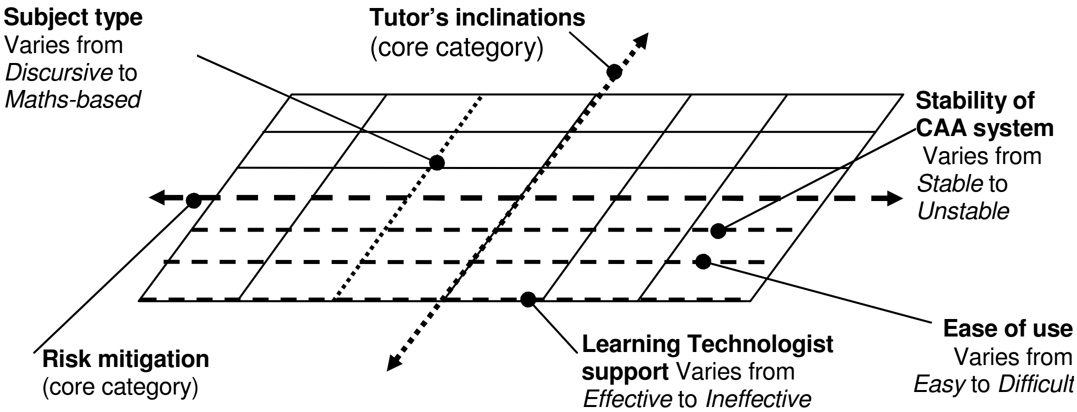


Figure 50- Cross-cutting Subject Type with Risk Mitigation

The number of citations by tutors of discursive subjects was weighted by a factor of two in order to facilitate direct comparisons with tutors of mathematically based subjects. After redressing the balance in this way, it was apparent that compared with tutors who taught mathematics based subjects, tutors of discursive subjects were proportionately less concerned about

- Effectiveness of [learning technologist] support, which was almost uncited by tutors of discursive subjects. A lack of central [CAA system] support was cited as an obstacle seven times less frequently
- CAA system stability, cited as a driver half as frequently
- Ease of [CAA system] use, cited half as frequently

Comments made by tutors of mathematically-based subjects supported the significance of making CAA systems accessible and fit for purpose; particularly in high stakes summative assessments:

> For final summative assessment on-line, there are many technical difficulties to overcome and the whole operation is much more complex than a normal paper exam… [so learning technologist] support is essential… (Tutor AmO5F001)
>
> Stability i.e. have something that does the job and do not keep changing the system (Tutor AmN5M001)
>
> Because [the new system made it] easier for me to edit the questions, in fact I did the editing far more thoroughly this year (Tutor AmO5M007)

It appeared that tutors who taught mathematically based subjects used CAA for summative assessment purposes more than tutors who taught discursive subjects and therefore put a premium on risk mitigation.

Subject type and strategic factors

Cross-cutting strategic factors with tutors' inclinations showed that tutors of discursive and mathematics based subjects were sharply divided with respect to strategic resourcing for CAA (Figure 51). Tutors of mathematics-based subjects differed particularly regarding

- the provision of effective *support and training* (cited four times as often)
- being *allowed time* to learn and use complex CAA tools (cited as a driver three times as often)
- not being given *credit for [learning and teaching enhancements] using CAA* (cited as an obstacle twice as often)

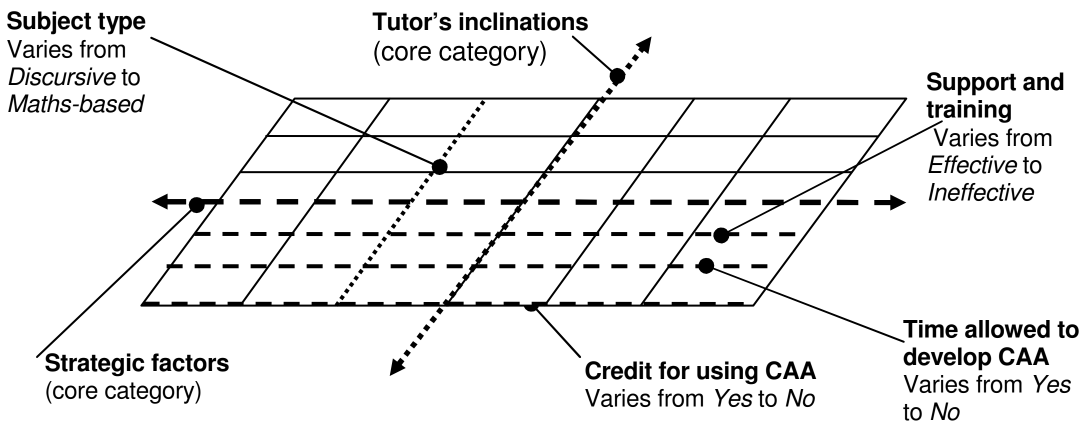


Figure 51- Cross-cutting Subject Type with Strategic Factors

Comments made by tutors of mathematically-based subjects indicated the importance of effective resourcing at the strategic level:

> Central server for software [and]… e-learning team for software support and advice is vital… (Tutor 'AmO3F004)

> [The institution should] reduce teaching load to spend time developing the tests (Tutor AmO3F001)

> Recognition of work done in terms of promotion - time spent writing CAA materials is not time spent on research. One only has 24 hours in the day! (Tutor AmN2M001)

It seemed that tutors of mathematically-based subjects were more concerned about strategic resourcing of CAA because they made more use of it for summative assessment:

> [Strategic resourcing] is vital for any successful deployment of CAA… if it's ever going to be accepted as a credible means of assessing undergraduates… (Tutor AmO4M002)

5.9.8 THE DYNAMIC NATURE OF THE UPTAKE PROCESS

The third question raised by the phase 1 analysis was the extent to which the balance of drivers and obstacles is static because tutors make up their minds early on and to what extent it is dynamic because they are susceptible to persuasion or dissuasion.

A key part of the model developed in phase 1 (section 4.7.6) concerned the *ameliorating effect of learning technologists actions* (such as implementing appropriate procedures and training) on significant operational and organisational obstacles. An example of an operational obstacle is *vulnerabilities in a CAA system* and an organisational example is the *presence of effective training and support* which had an ameliorating effect on obstacles such as *pedagogical naivety shortfalls* (section 4.5). These forces can be characterised in terms of their strength as drivers (and in their absence or mismanagement, as obstacles) and appear in the phase 2 infrastructure shell. The infrastructure shell was then directly mapped to the *infrastructural risk mitigation* plane in the initial phase 1 2 mini-framework (Figure 43).

Top-down cultural drivers such as the *shift towards MLEs* and top-down operational drivers such as *secure central financial resources* and conservatism in the cultural domain and *failure to allocate time* for the development of CAA in the operational domain (Figure 40) appear to influence tutors indirectly via the infrastructural shell and have therefore been abstracted into an outer institutional strategic (i.e. cultural) and resourcing (i.e. operational) shell. This institutional shell can be mapped directly to the *strategic factors* plane in the initial phase 2 mini-framework (Figure 41). The extent to which the balance of drivers and obstacles is static or dynamic was explored in the 2003/4 interviews.

The severe consequences of high stakes CAA failures

Students in higher education appear increasingly to embody a ‘complaint culture’ (THES, 2005c). Frustrated students felt justified in demanding that any problems with a CAA test should be speedily rectified and could be expected to take their grievances directly to the tutor who decided to use CAA. An important factor in this is that many students now pay at least some of their own fees and have more of a customer mindset. Students therefore put enormous pressure on tutors who felt they are being punished for their risk-taking:

> It was - it was just a very stressful time. I can honestly say that that weekend, I thought - we thought of nothing else… even worse was that the show goes on… so - what happens then is, the whole thing snowballs. If you don’t tackle it and immediately give them a solution - there were some comments about why they didn’t get the solutions even though it was the weekend, as to what we were going to do about it… so… all the time you’re trying to fend that off (Tutor AsO3M001)

In this case, the tutor reported informally that a consequence of this CAA failure was that an entire academic department changed its policy and discouraged any use of CAA for high stakes assessment. In fact he and another tutor from a different institution independently suggested that for every single CAA failure 10 tutors may be permanently discouraged from using CAA. These estimates do not include an unknown number who have been put off but aren’t heard from.

Under-reported CAA failures

One of the most surprising findings from the tutor interviews was the extent to which CAA failures appeared to be under-reported. Of the seven tutors interviewed in phase 2, three (from two different institutions) reported problems during the delivery of high-stakes CAA examinations that were severe enough to result in the tests being completely abandoned, but that these failures had yet to be written up internally (let alone published in the literature). This female tutor of a numerically-based subject in an old university described the severe consequences of a CAA failure in a high stakes test:

> …after we lost all those answers…because we didn’t know how to retrieve them, or even if we could have retrieved them…we had no alternative, we had to abandon it…because to do otherwise would quite possibly have invited appeals from…[students] who might have felt they were being treated unfairly (Tutor AsO4F002)

The same tutor explained that fear of criticism for not having followed procedures for ‘good practice’ was a powerful disincentive for publicising such occurrences:

> … Report it? To whom? The [CAA] system is run by [the IT department] and we have nothing to do with them apart from saying when the tests will be needed… [I

> think we were afraid] they'd tell us it was our own fault or something… its that nagging feeling you get when you forget to do something vital, like did you turn off the gas? (Tutor AsO4F002)

Market research indicates that people are much more likely to tell their peers about problems rather than to complain to a supplier and are far more likely to believe what their peers tell them than to believe a supplier (Barlow and Möller, 1996). This seems to apply even to highly educated people who are otherwise more likely to complain about problems than most people (Hyman, Shingler and Miller, 1992). On this evidence it could be assumed that a single failure will result in at least ten other tutors not using CAA who otherwise might have.

The consequences of CAA failure under-reporting

Because CAA failures are under-reported, some tutors' may work under the misapprehension that CAA is 'safer' than it really is. This may make them disinclined to consider the possibility of failure with the result that they fail to engage in common-sense risk management activities such as arranging a backup date, time and place ('slot') for re-takes:

> …those are second-year students, I think it would be difficult to get them again… no-one thought it could go wrong, so no-one scheduled another time… this is one offs. And it's basically that they have to - the reason that the results go back to the tutors is because the tutors then negotiate with the students any remedial work that they might have to do… once they go back into practice we lose them… (Tutor AsO4F002)

It is perhaps less surprising that when live failures occur, they have a dramatic and disproportionate effect on student and therefore tutor morale. This appeared to act in several ways at once; students are frustrated, tutors are disappointed that their investment didn't pay off and bad news travels fast.

Awkward authoring interfaces

Awkward authoring interfaces are an obstacle to uptake that appears to be exacerbated by the infrequent use that most tutors make of CAA tools. Three of the seven tutors interviewed made pejorative comments about the awkward user interface of one well-known commercial CAA system. It therefore becomes vitally important that system-specific training is delivered just-in-time:

> Well… I found it totally non-intuitive, the process. I found [it] painfully difficult. Now, I'd obviously only been on the course, that course once and then there was that long period… from that. I… use [graphics package 'A'] for image manipulation… I never look at the manuals… sometimes I'll go months without using [it]; then I'll fire it up and it all goes in… a very intuitive way of editing and I fire up [the CAA tools] and I'm asked a question - I don't actually understand the question it's asking me. (Tutor AmO5M007)

Another CAA user bemoaned the lack of productivity brought about by an awkward authoring interface:

> [Tutors] using CAA in this department are… [on] the latter part of the majority curve. And… that's a lot of learning of a product, just for two tests. And you learn it once and put your test up; and you've lost you skill then… you always have to keep relearning it, if you only use it once a year. Because I know now that I've forgotten a lot about what I learned… in a way I need a few more under my belt quickly to feel more comfortable. (Tutor AsO4F003)

In contrast to tutors who complained about the authoring interface of a particular CAA system and indicated this would deter them either from using the tools again or recommending them to peers, a tutor who used the same system found a strong argument for using CAA because the tools were perceived to be 'no more difficult than Word':

> My input there was just the creative part, so I created the questions and that was it, which I would have had to do for something the students did on paper anyway… I mean, apart from the fact that I had to create the questions myself, the intellectual creativity that I would have to do for any question set anyway…I thought [the authoring interface was] pretty straight forward. If it's no more difficult than [Microsoft] Word, you'll use it won't you? (Tutor AhO3F009)

Inadequate preparation of tests

A consequence of not testing items properly is that invigilators have to stop students working on bad questions at delivery time. This is made particularly difficult when items are delivered in random order (standard practice in invigilated tests) because no-one knows what question numbers to leave out.

Consequences of diagnostic tests

A consequence of diagnostic tests being delivered by CAA is that because this often happens at the beginning of students' university careers when they are still settling in, their experience of CAA may be felt as more onerous than would normally be expected:

> The fact that for them it was week two, they had only been at university one week and everything was very unfamiliar… [but] it's the only time where we can do it. Otherwise what's the point of diagnostic testing in week 10? But at the same time, I think you just add it to the students feeling of: 'Oh my God, here's another new thing that we need to do and I'm still not sure about all the other things that I need have done' (Tutor AhO3F009)

'How I invest my own time'

Tutors have a very limited amount of disposable time and this precious resource is jealously guarded. The inertial temptation to stick with tried and tested assessment modes is strong:

> It was - I could see that if we had to sit down and learn POSH-SYS, it would be a nightmare for a lot of people. Because we have this very tight schedule you know and their test is on paper and we've been doing it for donkey's years and it runs, you know you haven't got to think about it. (Tutor AhO3F009)

However, given the choice technophilic tutors may prefer to invest some of that precious time in learning a new tool that could save them time in the future than spend it doing more marking, which is seen by many tutors as a bottomless pit:

> ... if you tell me that I have to invest two of my hours doing that, it's probably something that I see as worthwhile, as constructive… - as an investment. Whereas if I have to spend the two hours marking… I wouldn't look at it with the same kind of enthusiasm… [although] learning the system took me a little bit longer than … doing the marking, I would see that as something worthwhile… You know, I can do two hours marking any day; I have enough papers to mark. So… [it's] how I invest my own time. (Tutor AhO3F009)

Uptake increases uptake

This is one of the few explicit citations of the mechanism of an increase in uptake increasing uptake still further. In this case it's because tutors and learning technologists realise the possibilities for extending assessment practice that are inherent in CAA tools having once used them, which is further support for the notion that *CAA drives pedagogic development*:.

> Listen, I'm keen; I think my people [are] engaging with this… [because] we realised… that you can start to move people into thinking differently about tests … so you can actually make a pedagogical shift by doing this… And it's interesting that once the test was up for this chap, he realised that it should be different… You don't think like that if it's on a bit of paper. So… he didn't think like that before… it suddenly looks different. (Learning technologist LmO4F003)

The phase 2 arrangement of drivers and obstacles was more detailed in terms of the number of factors that were teased out of the data and, to a lesser degree, the relationships between them, but the fine detail of the pathways through which these drivers and obstacle influence tutors was unclear at this stage. This represented a gap in the emergent theory that was addressed using the paradigm model.

Access to support conditional on prescribed CAA use

One senior learning technologist at a new university suggested that restricted access to learning and teaching support can be used deliberately to encourage tutors to become CAA users. The aim appears to be getting tutors to use CAA as a lever to improve assessment practice:

> So, we encourage tutors to use it formatively… And… we've made sure… [that] they need to meet our team to get the software onto their machine and to get set

> up on the server. So once they've made that connection [we provide]… support all the way through to the delivery of their sessions… So generally, if people come through our route - and there's no other route at the moment - they have to be exposed to those sorts of philosophies about how you use it effectively... (Learning technologist LtN5F001)

Technology diffusion and the importance of 'ease of use'

Mainstream adopters of technology-based products do not see what they are getting as a technology. Instead they see it as a utility that they simply plug in and use (Moore, 1999). For them, ease of use is taken for granted. It is apparent that learning technologists regard ease of use as a critical driver for the uptake of CAA. The problem they see is that most people already have the skills to use other comparable technology-based systems, which have become easy to use in recent years. However, CAA systems, particularly the fuller-featured ones, may require a level of IT skill significantly beyond that. For instance, when asked about the relevance of tutors' computer phobia (which had been identified as a significant obstacle in Bull and McKenna's 1999 UK survey) one CAA manager stressed an apparent mismatch between the kinds of IT skills that are sufficient to use a VLE and those required to use a full-featured CAA system:

> I think its more of a problem with the staff is their tendency to overestimate their ability to use computers. They think because they can browse the web they can program almost. They think maybe because they can use a wizard in POSH-CAA, that… they're an author for Computer-aided Assessment. So - there's a real jaw-dropping stage when they realise that the wizard isn't everything…and - it's just at that point that they realise that they actually know very little… (Learning technologist LtO3M004)

5.9.9 AMPHOTERIC INFLUENCES GOVERNING CAA UPTAKE

A question related to dynamic influences on uptake was to what extent other cultural or operational factors take on an 'amphoteric' character. Five new factors emerged during phase 2 axial coding as having the potential to act amphoterically and this tendency could be located on a continuum ranging from factors that changed their effect on uptake only under unusual conditions, to factors which readily changed their effect on uptake. In addition to *increased uptake* which emerged during the phase 1 analysis, factors which changed their effects only under unusual conditions included *requiring tutors to use CAA*, ability *of CAA to test entire curriculum width* and *restricted ability to test higher-order learning outcomes* (HLOs). Factors which appeared to change the direction of their effect rather more readily included *better feedback* and *under-reported failures*.

Amphoteric factors that seldom change polarity

The first of these is *increased uptake.* It may be recalled that under normal conditions where the capacity of the system has not been exceeded, *increased uptake* could itself be expected to work as a driver because word of mouth recommendations from CAA using colleagues are a powerful incentive for non-users to try using CAA. However, under other conditions where, for example, the capacity of the system has been exceeded, there is a risk of students' answers being lost and where this happens it acts as a very powerful disincentive. This can be to the extent that even current users who have invested heavily could choose to abandon the technology rather than risk something similar. The underlying 'bistable' mechanism was not explicit in the 2003/4 questionnaire returns, but the observable expression of this 'amphoteric' factor emerged in three ways. Firstly, the bifurcation of 'CAA system scalability' resulted in a driver called *stable resilient CAA system* and an obstacle called *unstable unreliable fragile system* which represents the bimorphic behaviour of CAA systems under load. Secondly, the learning and teaching infrastructure factors of *CAA champions* (a driver) and *vociferous critics* (an obstacle) account for the ambiguous effect of *increased use* on word of mouth recommendation. Thirdly, a tutor explained that a load-induced failure caused uptake to decrease sharply:

> And when the email came round about the disaster that happened with POSH-CAA: again some of those colleagues … just went non-linear over how we've … taken on something which under the most fundamentally obvious things that it had to work under, it fails at the first hurdle. (Tutor AmO5M007)

The second is *requiring tutors to use CAA* which was clearly a driver for the uptake of CAA in the sense that it prescribes for the use of CAA irrespective of tutors' natural inclinations, but could also be seen to act as an obstacle, albeit in a more subtle way. The conditions under which this switch seemed to occur appeared to be when this requirement included an element of coercion, or where learning technologists have to become involved for operational reasons. At this point tutors identified a conflict with cherished notions of academic autonomy:

> "…academics are usually autonomous in the way their courses are managed - now they will [have to] rely on technical support…" (Tutor AmN5F001)

The third is the *ability of CAA to test entire curriculum* which can be regarded as amphoteric because although the width of the curriculum that can be tested with objective items is usually quoted as an asset, if the test is of a relatively low overall worth (value) and it involves learning a very wide range of material from an overloaded curriculum, it becomes overly onerous. One tutor cited an example of this happening in a CAA test where the disproportionate amount of work required by medical students to score highly was sharpened by comparisons with other assessment modes, particularly essays, where a limited topic is researched and written up in depth and is worth a lot of marks because it tests the kind of higher-order skills which are so important at university level (tutor AmO5M001). Assessed 'wet' practicals in which medical students often participate were also cited as an attractive alternative to CAA because they were not seen to be as onerous for tutors to mark as essays.

The fourth amphoteric factor which changed 'polarity' only under exceptional conditions is the *restricted ability of CAA to test HLOs*, normally cited as an obstacle to the uptake of CAA. However, an example was cited by a tutor of a test which assessed basic knowledge recall where HLO testing was actually not wanted at all because the students had not, for reasons to do with staff shortages, been prepared to that level. The restricted ability of CAA to test HLOs changed under these conditions from an obstacle to a driver:

> … the third year material… is seriously difficult stuff… there have been difficulties within this [department] in terms of teaching this knowledge because we've got someone who has just retired… so… we shouldn't be pushing the level of difficulty in terms of the questions in the third year course at the moment... I kept it fairly simple and the majority were MCQ… (Tutor AmO5M001)

Amphoteric factors that readily change polarity

Factors which appeared to change their effects readily included *better feedback* and *under-reported failures*. Of these, *better feedback* is usually referred to as a driver for the uptake of CAA. However, it has the (perhaps unintended) consequence of making assessment more transparent, particularly assessment criteria. Once tutors realise that CAA can expose assessment criteria and marking schemes to greater scrutiny and potentially to have external examiners or unhappy students make accusations of invalidity, they may feel vulnerable.

The other factor which may readily change the direction of its effect is *under-reported CAA failures*. It might be assumed that CAA failures being so generally under-reported acts as a driver for CAA uptake because for many tutors, the illusion is maintained that CAA is less risky than it really is. But as soon as something goes wrong, the under-reporting of failures becomes an effective brake on uptake because failure comes out of the blue and confidence suffers. Tutors who have been using it may abandon it or reconsider the way they use it and tutors who were considering its use may find other ways to perform their assessment tasks.

5.10 Phase 2 paradigm model: Dual path uptake

Locke's (2001) interpretation of Strauss and Corbin's (1990) paradigm model is shown diagrammatically below and is adopted as a flexible visual tool for presenting discovered concepts and their interactions in context (Figure 52).

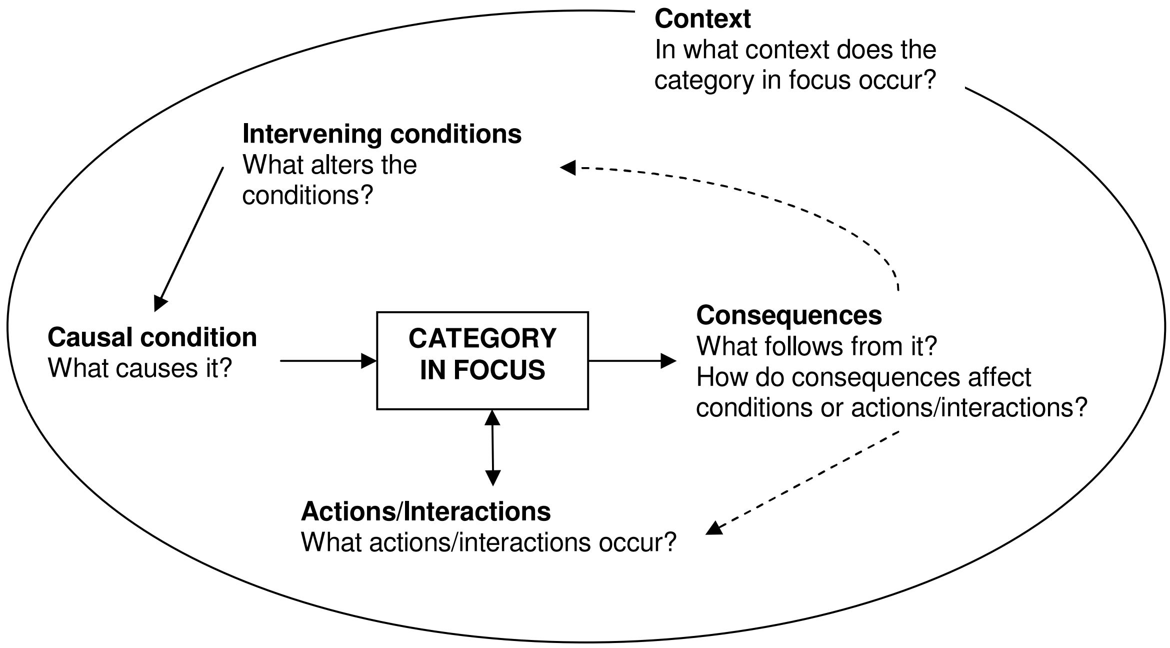


Figure 52- Strauss and Corbin's (1990) Paradigm model, after Locke (2001)

Dual path uptake

Two different kinds of trajectory emerged from the GT analysis of phase 2 data. These were largely conditioned by *tutors' motivations for using CAA*. A higher risk trajectory is associated with tutors' decisions to use CAA based principally on a desire for increased productivity. Lower risk trajectories are associated more with a wish to improve learning and teaching practice. In the case of the *high risk trajectory*, interactions may occur with peers whereby their *ad hoc practice* may discourage them from using CAA at all. This constitutes a vicious cycle whereby poor practice discourages peers from ever using the technology.

Intervening conditions are that the institution may, through its infrastructure, take measures to *reduce the risk undertaken* by making the CAA systems more resilient, or easier to use. Learning technologists and other support staff may assist in this risk mitigation process by training tutors and by supporting them in making good use of the systems. This makes it more likely that existing tutors will adapt their practice and *prioritise learning and teaching gains* which in turn will encourage *lower-risk trajectories*.

On the other hand, a lower risk trajectory usually entails more *structured practice* and is likely to *encourage uptake amongst peers* because it less likely to go wrong. Lower-risk trajectories also *validate existing good practice* and strengthen the conditions for tutors to prioritise learning and teaching gains, which constitutes a virtuous cycle whereby good practice encourages peers to imitate it. This 'dual path' pattern is shown for the first time below (Figure 53).

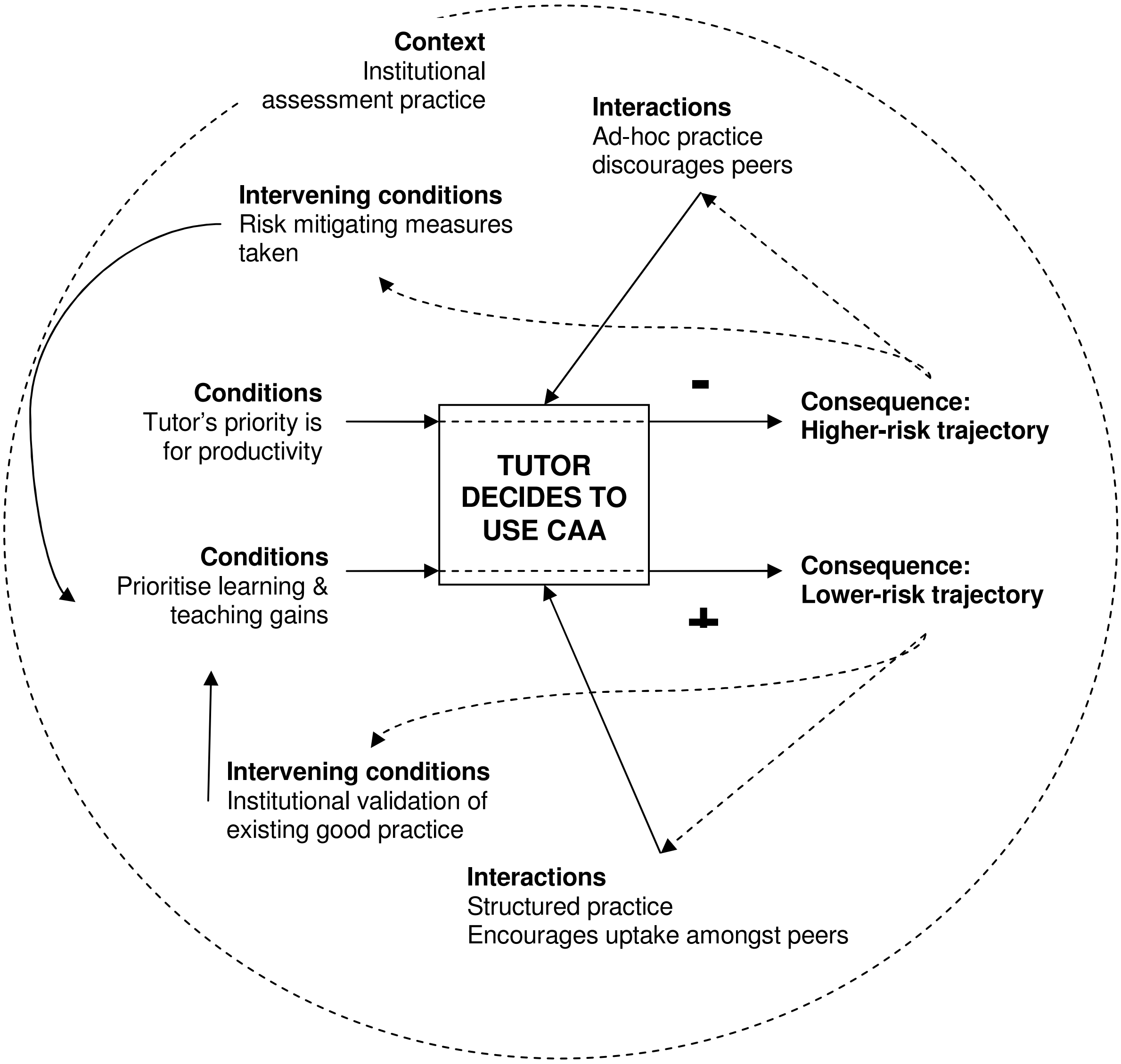


Figure 53- Paradigm model of dual path uptake

This is clearly shown in the 'concentric shell' model for the first time below, which is populated here by factors associated with a lower-risk trajectory (Figure 54). This model has much in common with Strauss and Corbin's 'conditional/consequential matrix' (1998a pp.183-199).

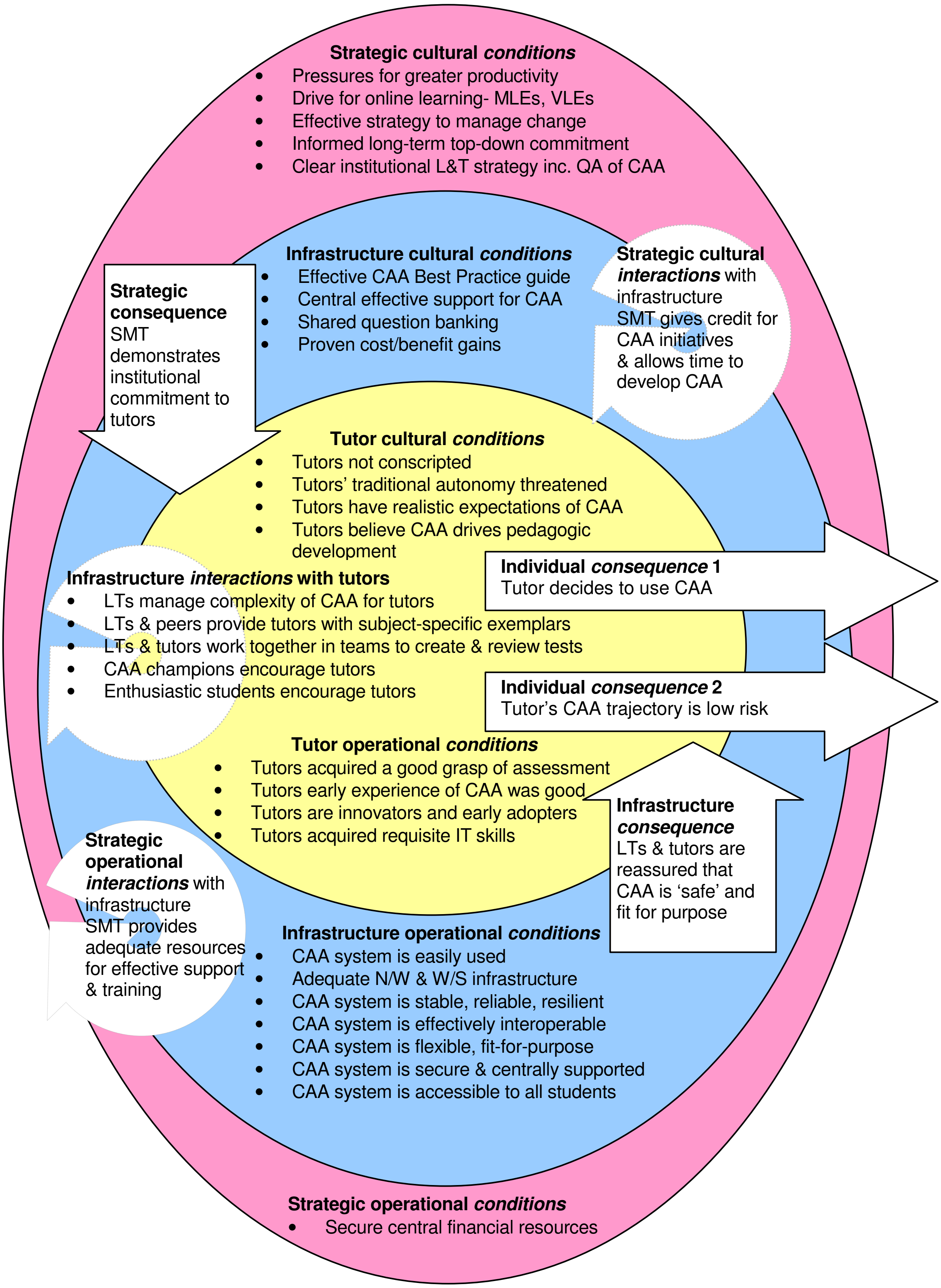


Figure 54- 'Concentric shell' model adapted for favourable tutor trajectories

5.11 Phase 2 selective coding

Selective coding in Strauss and Corbin's terms is where a single phenomenon is selected on the basis of its' ability to make sense of the entire problem under investigation (Strauss and Corbin, 1990; Strauss and Corbin, 1998a). One of the intended outputs from the phase 2 data analysis was therefore a single category that could be used to make sense of CAA uptake in higher education and in particular to answer the question of why it isn't higher which was the research question asked at the beginning of the study.

A concept which emerged at this stage as central to CAA uptake at the level of individual tutors was of individual tutor's *CAA trajectories*, which is defined here as a tutor's engagement with CAA from first experimental use up until they stop using it. This concept is clearly related directly or indirectly to the other categories which have already been described in the phase 2 analysis. Crucially, the type of trajectory is conditioned by the *tutors' motivations* which emerged as the core category.

5.11.1 THE CONCENTRIC CYLINDER MODEL

The 'concentric shell' model represents a 'snapshot' of the influences on tutors' decision making. This can be extended in the time dimension to produce a cylindrical model of tutors' decision making trajectories which is shown for the first time as the 'concentric cylinder' model (Figure 55). This shows clearly the insulating effects of institutional, infrastructural and individual inertia, which act cumulatively both to delay and attenuate the effects of strategic learning and teaching initiatives.

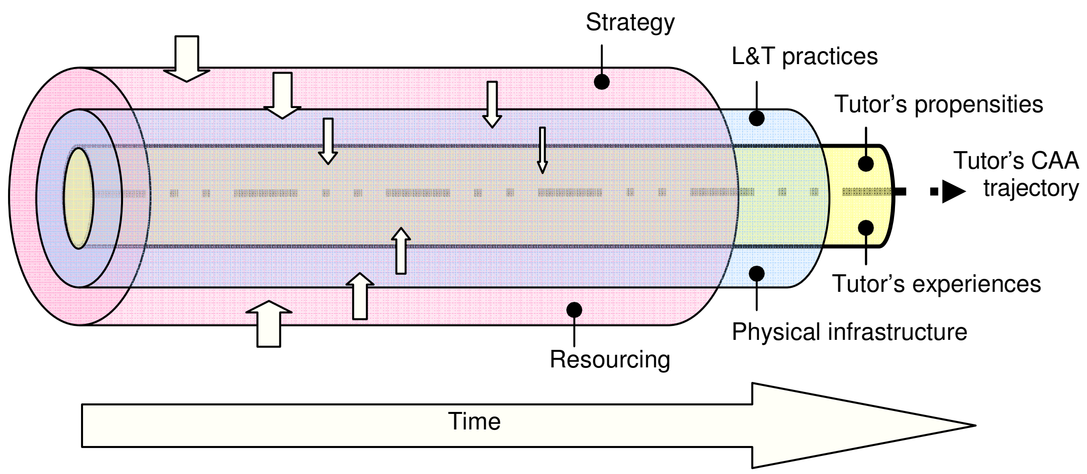


Figure 55- 'Concentric cylinder' model of influences on tutor's trajectories

Tutors' trajectories have a reciprocal influence on institutions in terms of strategy and resourcing. They also, in a similar way, influence mediating infrastructural elements such as general pedagogic practice and the architecture of physical infrastructure (Figure 56).

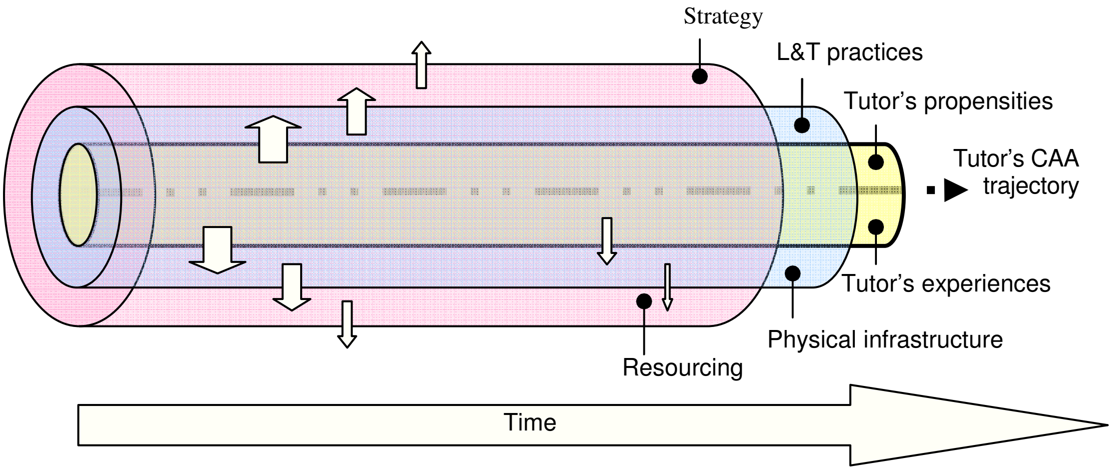


Figure 56- 'Concentric cylinder' representation of tutors' influence on institutions

5.11.2 THE TRAJECTORY MODEL

The trajectories which emerged from selective coding as most typical of current CAA practice are summarised in Figure 57. They are:

- Adhering to the structured institutional strategies (*linear institutional*) incurs least risk and the greatest chance of progression to the technology becoming embedded.
- Tutors who stick to a plan (*linear*) and implement CAA starting with low stakes then moving to progressively higher stakes testing incur least risk.
- Leapfrogging stages (*ad hoc*) entails taking on unnecessary risk which may result in difficulties and the technology being abandoned (*disastrous*).
- The most likely cause of CAA testing being abandoned appears to be an originating tutor moving on and no-one picking up the baton (*cut short*).

These typical trajectories are summarised below (Figure 57).

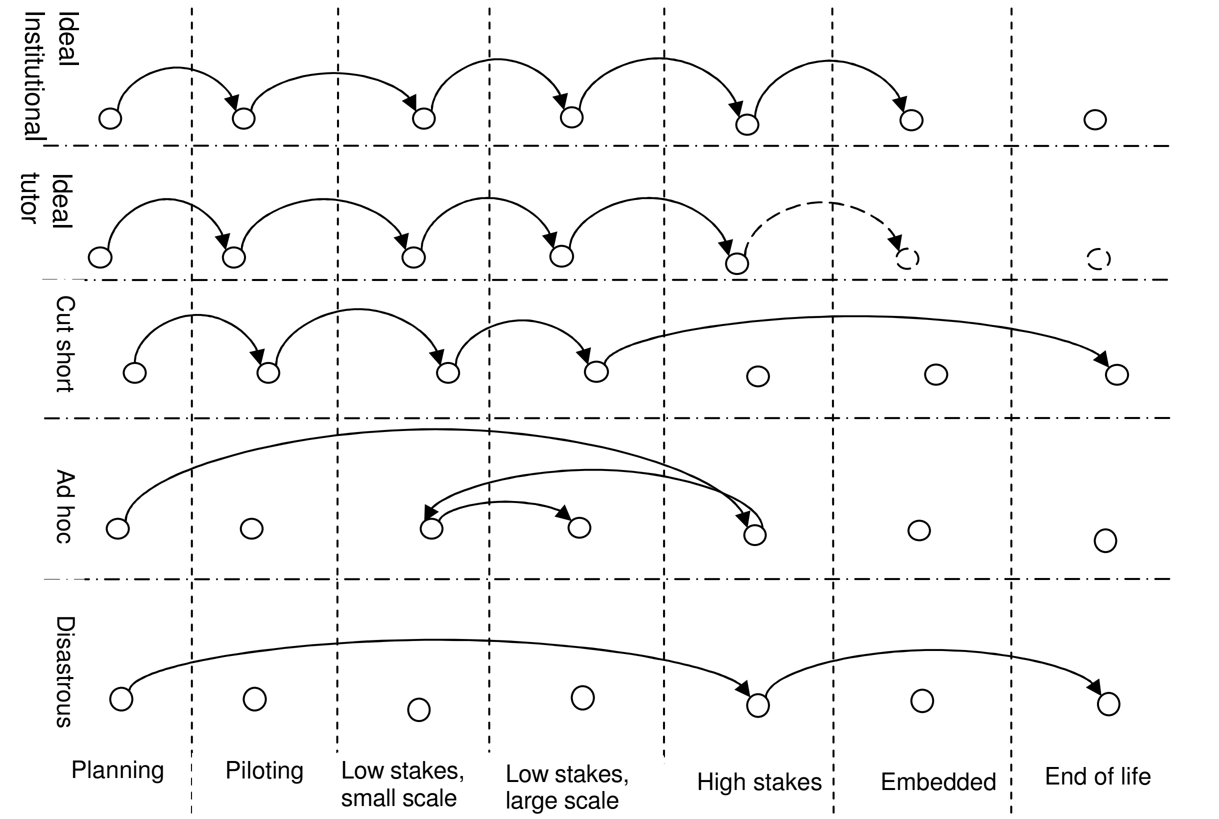


Figure 57- Typical CAA trajectories

5.12 Metrics for 'success' in implementing CAA

One of the questions raised at the outset of the research was what metrics can be used to assess the 'success' of CAA applications. The following dimensions emerged from discussions held with tutors and learning technologists:

a. Level of **integration** with corporate ICT systems, for example with MLEs or VLEs.

b. The width of practice in terms of **scale** (Number of users, Number of tests, Range of items, range of assessment stakes (diagnostic/formative/summative) and subject type (Humanities/Quantitative Science/Qualitative Science).

c. The extent to which CAA has become **embedded**, in other words is taken for granted and has become 'invisible' was seen as a reliable metric of success.

d. It was clear that the perspectives of different stakeholders diverged sharply with respect to criteria of success in CAA. Learning technologists wanted to see innovative applications of the technology which made the best use of resources and justified their existence, whilst tutors wanted CAA applications to preserve investments and which didn't attract criticism from students or management. QA staff and managers were said to prefer defensible CAA practice (Figure 58).

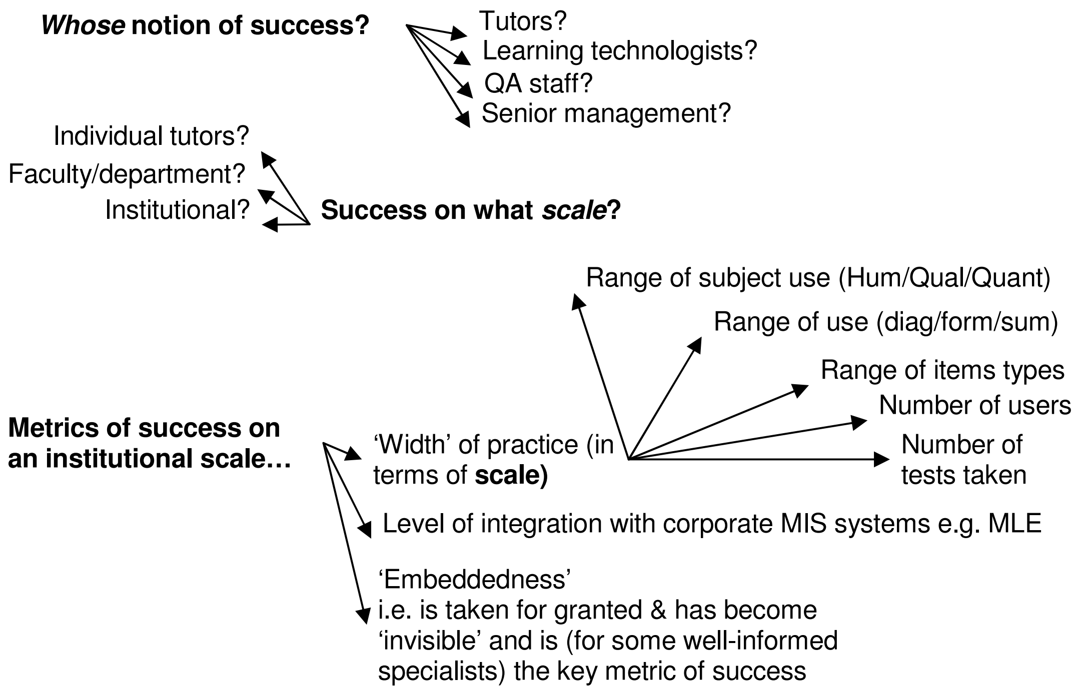


Figure 58- Metrics for successful implementation

5.13 Validating the emergent theory

The next stage was to present the findings in the form of an emergent theory to a sample of well-placed and well-informed tutors, learning technologists and senior managers. This was to be carried out by presenting the findings in the form of a MS PowerPoint presentation some weeks in advance of face-to-face interviews which were of approximately an hour's duration in each case. These phase 3 interviews would be, as before, transcribed verbatim and the transcripts verified by the respondents. A full GT analysis would be performed and the resulting theory written up.

5.14 Chapter summary

This chapter is the second part of the data theory section. The gaps identified in phase 1 were addressed and the phase 2 data collection activities were described followed by an account of the GT analysis. The resultant open and axial coding cycles were described, including the emergence of strategic factors, risk mitigation and tutors' inbuilt inclinations as core categories. During selective coding, tutors' motivations emerged as the central category which was used to make sense of the phenomenon of CAA uptake. The next chapter presents the final validatory phase of GT data collection and analysis in which the emergent theory was presented to both previous and new respondents.

6 Phase 3 GT data collection & analysis

This chapter comprises the third part of the data theory section and presents the activities undertaken to validate and refine the emergent theory of CAA uptake. Classically, grounded theories can be assessed for maturity by testing for saturation (Glaser and Strauss, 1967; Strauss and Corbin, 1990; Strauss and Corbin, 1998a):

> … no new information seems to emerge during coding, that is, when no new properties, dimensions, conditions, actions/interactions or consequences are seen in the data…Saturation is more a matter of reaching the point in the research where collecting additional data seems counterproductive; the "new"' that is uncovered does not add that much more to the explanation at this time. (Strauss and Corbin, 1998a p. 136).

This point was judged to have been reached after phase 2 coding ceased to bring further refinements (section 5.8). The process represented by the bold elements below (Figure 59) culminated in phase 2 selective coding where the emergent theory of CAA uptake was presented according to the central concepts of tutors' motivations and subsequent trajectories (section 5.11).

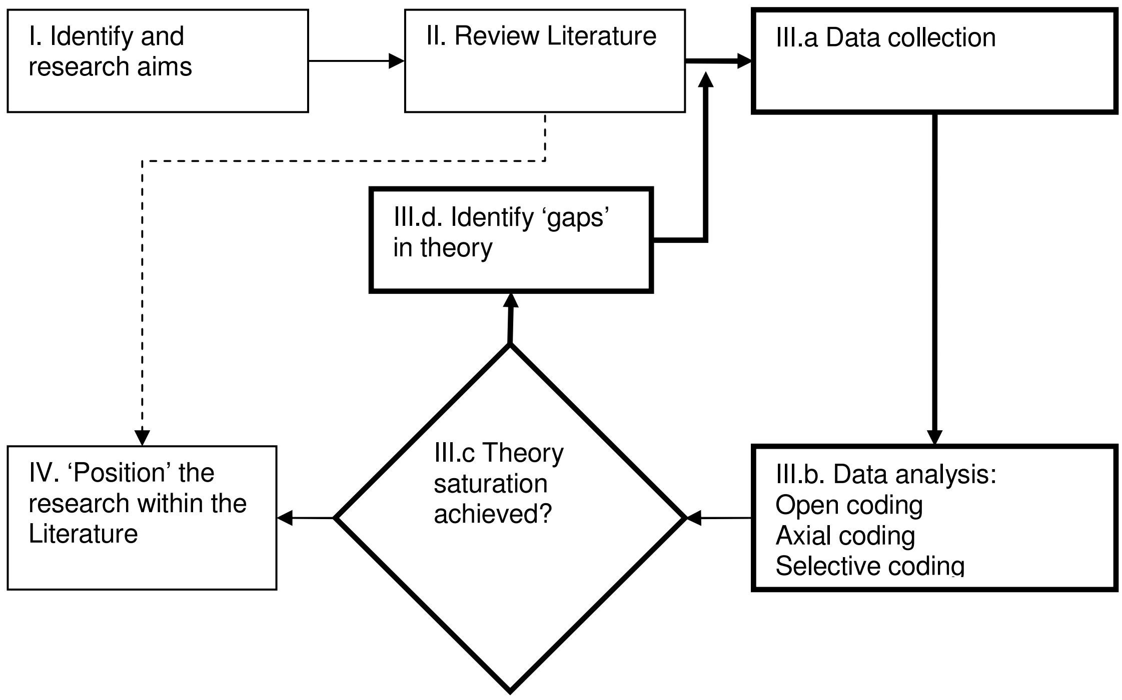


Figure 59- Research process workflow (after Harwood, 2002 p. 69)

It should be noted that the same approach which was taken to open and axial coding in phase 1 and 2 (discussed at length in chapter 4) was also used in phase 3. In order to avoid taking up a significant volume of the thesis with detailed descriptions of how categories emerged from the data and how their properties and dimensions were identified, the tables and description rendered in chapter 4 should be taken as an illustration of the way these tasks were managed in phase 3. However, summaries of adaptations and amendments made to the emergent theory in the light of the fresh data that was collected in phase 3 are provided, together with the rationale for making these changes.

The Oxford English Dictionary defines a *theory* as:

> A scheme or system of ideas or statements held as an explanation or account of a group of facts or phenomena; a hypothesis that has been confirmed or established by observation or experiment and is propounded or accepted as accounting for the known facts; a statement of what are held to be the general laws, principles, or causes of something known or observed. (OED, 2004)

It follows that the characteristics of a theory (compared to a mere description or a simple hypothesis) are that it should be coherent, that it should explain the phenomena under study and it should be possible to make generalisations from it. This implies that it should make predictions possible.

Strauss and Corbin propose a number of criteria for validating grounded theories (Strauss and Corbin, 1998a p. 269). According to their prescription, grounded theories are verifiable by comparison with real-world examples of the kind of practical problems that the theory was developed to describe. Characteristics of mature grounded theories are that they should be coherent and should 'ring true' to those involved. Furthermore, they should have explanatory and predictive power. A set of questions was compiled for use in the phase 3 interviews that tested the emergent theory according to these criteria (section 6.1.1).

6.1 Phase 3 Data Collection

The phase 3 data collection and analysis activities were as shown earlier in context with the other phases (Figure 19).

6.1.1 THEORETICAL SAMPLING FOR PHASE 3

Strauss and Corbin (1998, pp.156-161) suggest that emergent theoretical frameworks should be validated where possible by original respondents. A sample of 12 learning technologists, tutors and senior mangers was therefore selected for the phase 3 validation exercise according to the criteria that (1) they were well-placed and made 'credible witnesses', (2) that at least some of them had provided responses during phases 1 or 2. This included two learning technologists who had been interviewed in phases 1 or 2 and were international experts. Four tutors who had provided detailed responses to the phase 2 questionnaire were also chosen, three of whom had published widely on CAA applications. Four of the phase 3 respondents were learning technologists chosen for their national reputations as assessment specialists with an interest in CAA, one of whom was conducting PhD research on making CAA more accessible. One respondent was selected because of his national reputation as an educationist and senior administrator and also because he was well placed to offer a quality assurance perspective. The remaining respondent was a nationally-known VLE administrator with an interest in CAA who was chosen for his experience in MLE building by virtue of having managed the successful integration of a VLE with a central student record system. The phase 3 respondents are listed by their anonymised labels (Table 37).

Respondent ID	Original respondent?	Perspective
LtO3M001	Phase 1 interview	LT, Head of e-learning at an old university
AmO4M010	Phase 2 questionnaire	Tutor, e-learning researcher at an old university
AmN3M007	Phase 2 questionnaire	Tutor, CAA researcher at a new university
AsO3M002	Phase 2 questionnaire	Tutor, interest in CAA at an old university
AsO3M016	Phase 2 questionnaire	Tutor, e-learning researcher at an old university
LtO3M002	Phase 2 interview	LT, Head of CAA at an old university
LtN3F008	No	LT, e-learning researcher at an old university
AmO5M006	No	Tutor, Head of QA at an old university
AmO5M007	No	Tutor, Head of Assessment at an old university
LtN2M003	No	LT, CAA practitioner & researcher at a new university
AsO5M009	No	Tutor, Management and QA specialist
Lt2OM008	No	LT, VLE administrator

Table 37- Phase 3 respondents

A PowerPoint presentation showing the emergent theory (appendix D) was emailed to all respondents a few weeks before the interviews were due to take place and together with the interview script provided a basis for discussion during the interviews.

Because the primary aim of these interviews was theory validation and data collection was only a secondary aim, they were deliberately arranged to be nearer the structured end of the continuum rather than the earlier semi-structured interviews that took place during phase 1 and 2 data collection. Respondents were invited to comment on details of the emergent model and at the end of the interview they were asked a set of questions which were design to assess the integrity of the emergent theory (Table 38).

Validity of the emergent theory	
1.	Is this coherent - i.e. does it make sense as a description?
2.	To what extent does it ‘ring true’ as an explanation of CAA uptake?
3.	Given knowledge of an institution’s processes and priorities, what kinds of predictions are possible?
4.	Are there any obvious gaps in the theory?

Table 38- Questions asked during phase 3 interviews

6.1.2 THE PHASE 3 TRANSCRIPTS

Each phase 3 interviews was transcribed verbatim within a few days of the event and the transcript was emailed to the respondents for checking. All the scripts were approved as accurate records although, as in the case of the phase 1 and 2 interviews, several respondents specified some typographical corrections. This indicated that those respondents at least had taken the trouble to check their scripts quite closely. This resulted in a set of transcripts totalling more than 67 000 words (compared with a totals of 75 000 words in the 16 phase 1 and 2 transcripts and nearly 54 000 words in the 2003/4 survey by questionnaire) which were subjected to the same analytical processes used in phases 1 and 2. Nearly 200 000 words were analysed in the combined responses from the three phases of data collection.

6.2 Phase 3 data analysis: open coding

The same tools and techniques that had been used earlier in the study were used to analyse the interviews. The 12 interview transcripts were first broken down into major themes and then during a second open coding pass at a microscopic level, each phrase was coded. It was found that all the respondents agreed with the basic elements of the emergent theory and in many cases provided additional support in the form of observations and anecdotes. Two sets of categories directly related to questions about the status of the theory emerged from this exercise, the first of which directly supported the presented model and extended its scope. The second was of statements which proposed exceptions to the model. These categories were used in two ways: firstly to refine and add density to the emergent model and secondly to define exceptions to the model (Strauss and Corbin, 1998a p. 271).

Following this, a third open coding pass saw the new phase 3 categories merged with the existing coding scheme that had been developed in phases 1 and 2. As in phase 2 the analysis then proceeded to axial coding where comparisons were made between learning technologists and tutors, centralised and decentralised institutions and old universities and post-1992 institutions.

Many of the comments regarding perceived gaps in the theory stemmed from unexpected interpretations of the diagrams which led to some fruitful discussions about the underlying assumptions made in the research. These misunderstandings resulted in less ambiguous diagrams and provided a focus for the final stage of analysis.

6.2.1 SUPPORT FOR THE THEORY

Coherence of theory as a description

Phase 3 respondents were asked about the extent to which the theory comprised a coherent description of CAA uptake in UK higher education institutions. Respondents were in general agreement that the theory as presented formed a coherent narrative that described CAA uptake:

> It does make a lot of sense to me and it does ring lots and lots of bells. It resonates with my own experience; a lot of it resonates with my own experience… you seem to have a very, very good sort of hook into the way tutors actually feel about this… I think you're spot on. (Learning technologist LtN3F008)

> … your model… certainly does describe the experiences we've had… it catches the flavour of it… I think it does 'ring true' as a description, it certainly does, yes. (Tutor AmO5M007)

> What you've put forward, I wouldn't argue with it at all, I think it's reasonable. (Tutor AmN3M007)

> Yes… I think so. 'Does it ring true?' Yes. (Tutor AmO4M010)

Academics and learning technologists agreed that CAA uptake is so complex with so many different factors that a single 'big picture' would be almost impossible:

> That's the nature of research… [in learning technology] and you'd be very lucky to wrap it up in one picture. (Tutor AmO5M007)

Explanatory power of theory

Phase 3 respondents were generally in agreement about the extent to which the theory explained observed patterns of uptake:

> In my experience, yes - most of the factors, the barriers to adoption in our institution have been identified and the key issues are definitely more highlighted such as training, resource implications… (Learning technologist LtN2M003)

> Yes it does explain the uptake. I think it explains that in order for things to be successful, everything needs to be taken care of - the infrastructure, the policies, the practices, the training and so-on. And it's something that takes a lot of time to get it right. (Learning technologist Lt2OM008)

A learning technologist thought the theory helped to explain the way in which strategic resourcing limitations depress uptake:

> I think you have [identified the mechanisms] because we got the funding through to pilot it so this was coming from Information Systems, services infrastructure within the university that's where the money came from we piloted it as a department but we had very little resources made available… they were not prepared to take the next step to make it really feasible… that would have alleviated one of the barriers and [made] it more efficient of staff time which would then drive uptake with other departments. (Learning technologist LtN2M003)

Another learning technologist highlighted the theory's contribution in making apparent the bidirectional and dynamic nature of forces affecting uptake in institutions:

I can definitely see that it works both ways as the institution has an effect on what the tutor can do and in turn the tutor can have an effect on [uptake]… It definitely makes sense, yes. (Learning technologist Lt2OM008)

Academics generally thought that the theory explained the mechanisms behind uptake:

I think you put your finger on it…. Yes I think it certainly does have explanatory power… [and] you're asking all the right questions… it's basically all there… and I do think you are totally right about the infrastructure and operational conditions… (Tutor AmO5M007)

I agree with you. It's particularly interesting to look at the interactions that you're suggesting here because they do actually reflect a lot of my experience; I've never seen it all laid out in one picture like that before (Tutor AmO5M006)

Academics were enthusiastic about the explanatory power of *tutor's trajectories*, particularly when discussing the slides showing some of the typical trajectories that had emerged during the phase 2 analysis:

Yes, yes - that's does put it very well, actually. That's interesting, I like that diagram [indicates 'trajectories' slide], I thought that was really intriguing. (Tutor AmO5M007)

I think that's a neat way of presenting it. As you say, that's the ideal way, sort of stage by stage, step by step… and then you get to that point [indicates embedded point] and it is embedded… I liked this one as well [indicates 'cut short' trajectory], because I think there's a temptation for some people that they start off with very good intentions, thinking 'oh yes, we will do it stage by stage', but then there's a sort of impatience factor that starts coming in. (Tutor AsO5M009)

One tutor saw colleagues developing CAA applications that provided productivity benefits, but then being reluctant to do go further (Figure 60):

I think there's another one in there where you do get the inheritance factor of where at any particular stage something might be inherited and it just stays there… 'twist or stick' … It continues but doesn't actually go any further. (Tutor AsO3M002)

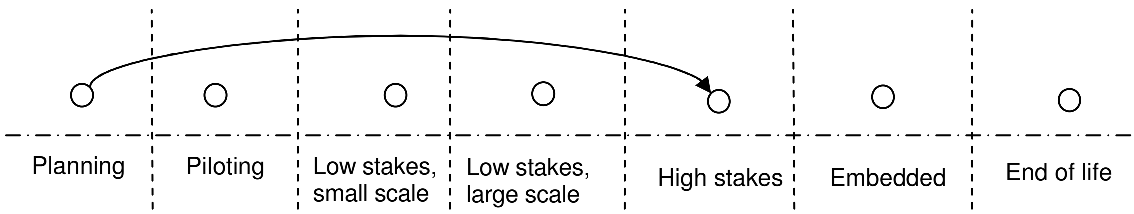


Figure 60- 'Twist or stick' tutor trajectory

Predictive power of theory

Phase 3 respondents were asked if they saw the theory as having predictive power. Tutors and learning technologists agreed that making generalisations of this kind are difficult because universities are complex and diverse organisations that differ markedly in funding and governance:

> I've seen some… universities where you don't have to convince anybody, you can just do anything you fancy there, but at Aldermire you have to go through such-and-such a committee to get anything in… on the whole to get something recognised at a strategic level is usually quite a rigmarole… I mean, I know a couple of weird universities which I've worked in and you think 'well the things I thought should be central are not central'… (Learning technologist LtI3F002)

Despite general reservations about the practicality of obtaining a sufficiently detailed knowledge of an institution's practices and organisation, respondents saw circumstances where the theory might predict patterns of uptake. A tutor described how making a well-defined set of initial assumptions as inputs to the model produced useful predictions:

> You can make predictions under certain external assumptions…let's suppose… that [if] the UK secondary school system moves increasingly towards… e-Assessment... [that] would put such strong pressure on your cylinder… outside inwards. But it would also work inwards, because [if]… the lecturers themselves… like what they're getting, they will want to give it to their students as well. So… [according to the model] for bastions of no change, it would be the outside ambience that will eventually dominate: and… one could predict that in places where there's a stout resolute set of outer perimeter defences… it will be the infiltration model. (Tutor AmO5M007)

6.2.2 PROPOSED EXCEPTIONS TO THE THEORY

When phase 3 respondents were asked if they could see any gaps in the theory, criticisms fell into two main categories. Firstly, it was seen to lack the coherence and detail of a case study approach and secondly, the complexity of universities militated against being able to account for all the processes at work. As an example of the first kind of criticism, a learning technologist had reservations about the theory's coherence (no single diagram summarised the findings) and precision because individual institutions were not described:

> You haven't given us one description though, you've given us several…I think the messages get very distorted on the way down and up and I'm not sure that's shown clearly…You need 3-d graphics with fly-through… I think the set of tools you've got is useful. But not enough about individual institutions… (Learning technologist LtI3F001)

The second kind of criticism applied more to the scale of developing an inclusive model for CAA uptake in UK higher education:

> What you've put forward, I wouldn't argue with it at all, I think it's reasonable. But I think the development of a model [with predictive power is]… going to have so many degrees of complexity and maybe you're going to have to look at what type of institution are you, then if you're that sort of institution, what sort of funding, what have you got. (Tutor AmN3M007)

It was recognised that universities vary widely and that predictions might have to be restricted in terms of the extent that an institution can be described in terms such as organisational structure and funding models.

The 'dual path' model of tutors' decision making

A learning technologist pointed out that efforts to improve the physical infrastructure are said to have only a coincidental benefit in reducing CAA risks. In the same way, low risk trajectories are said to have been the accidental by-products of approaches that maximise learning and teaching benefits, rather than the result of a deliberate process of risk mitigation:

> In terms of risk mitigation by …my institution in particular, I think there's very little of that kind of activity… But in terms of the lower risk trajectory, which is prioritising learning and teaching gains, I think… there is an improvement in learning and teaching as a consequence of adopting a lower risk trajectory, but… it's a coincidence rather than what they were aiming to do in the first place (Learning technologist LtO5M006)

If the prime motivation of learning technologists was other than CAA risk mitigation this does not appear to change the basic process described by the model, which is that the institution has effectively mitigated CAA risk via learning technologists working at the infrastructural level. Equally, if tutors are motivated primarily by a desire for learning and teaching benefits which leads them to adopt low risk practice, rather than a desire to minimise risk *per se*, the model remains valid since the outcome was less risky. It is difficult to disentangle desires for improvements in learning and teaching from low risk assessment practice because the two go together and are internal motivations that can be assessed only through tutor behaviour.

Two learning technologists argued against the majority view that formative assessment applications represent a lower level of productivity than summative applications:

> I was quite surprised when you said about high risk being productivity gains… because to me the productivity gains, or a lot of them, are at the formative end, certainly in my subject area. (Learning technologist LtN3F001)
>
> People seem to be mesmerised by the illusion that as soon as they pick the tool up they're not going to have to do any more marking for the rest of their lives. But actually no-one knows what the cost-benefit of summative applications is anyway… if you look really closely at the best formative set-ups they are really saving a lot of tutor contact time that would otherwise be wasted, almost, in remedial teaching… (Learning technologist LtN2M002)

It should be noted that this point was made by learning technologists who have an interest in promoting the use of CAA tools for enhancing the learning process. In contrast, tutors who were interviewed talked more about the productivity benefits of diagnostic and summative applications which are relatively infrequent and the effects of which tend to be longer term.

6.3 Phase 3 data analysis: axial coding

6.3.1 ADJUSTMENTS TO THE PARADIGM MODEL

The dual path model of uptake that emerged in phase 2 was criticised by one phase 3 respondent for not allowing levels of risk other than high and low. If the high and low risk trajectories are not strict alternatives but a continuum, then the two paths would represent limits to tutor behaviour which would still entail higher and lower risk trajectories. It was pointed out that some tutors had started with summative applications with what appeared to be low risk trajectories, which contradicted the basic assumption behind the dual path model. It appeared that tutors were performing their own risk mitigation: risks incurred through decisions to use CAA made on the basis of productivity were effectively mitigated by previous experience with objective testing:

> For example [a science department] wants to look for particularly first year examinations for implementing CBA. Now the interesting thing is that they have a history of using other types of [assessment] technology… So they have a great deal of experience in designing MCQs … But they have gone very much for… a high risk trajectory. But they've been very successful at it… But I think that's a consequence of their experience… from other forms of standardised testing. (Learning technologist LtO5M006)

This resulted in three adjustments being made to the 'dual path' paradigm model. Firstly decisions made primarily for productivity reasons resulting in risk trajectories were shown to vary from low to high risk. Secondly a 'tutor risk mitigation' condition was added to the dual path paradigm model. Thirdly, a complementary range of risk outcome was shown for decisions driven primarily by learning and teaching conditions: it is easy to imagine a CAA application having a higher risk outcome than expected due to unnecessary risks being taken, although learning and teaching-driven applications appear to be of inherently lower intrinsic risk. This scheme is further developed in section 6.4 (selective coding) below.

6.3.2 RISK DISCOUNTING BEHAVIOUR

Risk discounting behaviour is one of two aspects of tutor behaviour that lead to CAA applications being run in the high-risk domain (Figure 53). A tendency had emerged from the interview data for tutors to go ahead with CAA assessment applications which, according to well-known risk metrics, ought not to be commissioned without further risk mitigation. At the root of decisions to proceed in the face of more or less explicit warnings was the desire to lighten an assessment burden which was seen by tutors as being otherwise difficult to bear.

Rather surprisingly, tutors sometimes embarked on this course even though they knew it was risky and in some cases with the connivance of learning technologists who ought perhaps to have known better. One learning technologist rationalised such behaviour in the following way:

> We… went straight into summative… we justified it to ourselves by kind of pretending [that] it wasn't really as risky as all that and we didn't ask the administrators or the network guys what they thought… The system had not been tested with [a large number of students] logged on simultaneously… it was sort of very risky… if it fell to pieces… it was quite a high risk, really… we needed productivity gains. (Learning technologist LtN2M003)

The other aspect of tutor behaviour that emerged as having the effect of causing assessments to be run in the high-risk domain was *naïve attitudes to technology* cited by learning technologists. This was said to mislead tutors into taking on more risk than they intended and which was linked to an alleged failure to grasp the complexity of underlying technology which tended to discourage colleagues uptake:

> They don't understand the ideas of load on a system, or the practicalities of the network or some of the things that could just go wrong…Well, you could definitely say that a little knowledge can do a lot of damage… an instructor thought 'I'm not so keen on this 'what you see is what you get'' and… put in some HTML. And the HTML that he'd done was completely bugged and just wrong… And… they haven't come up with how they're going to solve it yet. (Learning technologist Lt2OM008)

6.3.3 RISK TAKERS ARE PUMP PRIMERS

It was pointed out that an effective way to increase uptake is to concentrate on summative assessment for the productivity benefits it brings, because this means that not only is the tutor very likely to continue using CAA but that hard-pressed colleagues will emulate this practice. A common view among tutors is that formative, lower-risk practice entails a lot of work for little tangible benefit; which will tend to discourage potential users. It is argued here that summative risk-takers are needed to raise the profile of CAA in order to encourage potential users, which appears to be very like the notion of 'CAA champions' advocated by some learning technologists:

> And if they're doing formative… that does go against the actual speed of uptake. I see people saying 'I did this and this, its formative' and [I] say 'well, what were the gains?' 'Oh, I think the results were better this year'…but its just 'I think'… Whereas … if they see people taking a high risk road and having success… they may not go the high risk road themselves, but they can see the benefits then. So having high risk takers in an organisation does have an advantage in pulling other people in to it. (Tutor AmN3M007)

It is important to keep in mind that 'quick win' high risk approaches constitute an amphoteric factor because they only encourage colleagues to use CAA so long as this approach is not seen to be risky.

6.4 Selective coding in Phase 3

According to Strauss and Corbin, selective coding is a process of selecting the core category and relating all the other categories to it: '… it is not until the major categories are finally integrated to form a larger theoretical scheme that the research findings take the form of a theory. Selective coding is the process of integrating and refining categories' (Strauss and Corbin, 1998a p. 143). This section describes the emergent theory in terms of how the other categories are related to the core phenomenon which emerged as *dual path uptake*.

6.4.1 CONTEXTUALISING TUTORS MOTIVES

The core category: tutors motives

The pattern of CAA uptake over time at the level of individual tutors - their 'trajectory' - is the fundamental unit which, on the micro scale, underlies institutional uptake on the macro level:

> This only makes sense in bulk when you consider a large number of tutors all going through this cycle and then the aggregate effect of all this will be a trend towards either doing it or not doing it, through these various mechanisms. (Learning technologist LtN2M003)

A tutor's CAA trajectory differs critically from otherwise similar patterns of technology uptake such as VLE use in that a significant element of risk attends technology-based assessment activities, particularly in credit-bearing assessment:

> When you get failures… its very public, rather more than computer-based learning… [but] if email runs down for 10 minutes well, try again later; so the stakes are higher. (Learning technologist LtO5M002)

Individual CAA trajectories can be broadly characterised as high or low risk according to the fashion in which tutors progress towards high stakes assessment. Where uptake proceeds in a planned sequential fashion from testing through formative to low and then high stakes summative testing, small increments of risk are incurred in each step which results typically in a linear low risk trajectory. Where uptake proceeds directly to summative use, large increments of risk may be incurred at once which results typically in a non-linear high risk trajectory. The biggest influences on the CAA trajectory described by a tutor were their motives for using CAA in the first place. Where the aim was primarily to secure productivity gains the consequence was an *ad hoc* style of use that resulted in high risk trajectories. Where the aim is primarily to improve learning and teaching practice the consequence is a more sustained progression through the different stages of CAA use that results in lower risk trajectories.

Quick wins?

Time pressures on tutors across the sector are well documented (Bull, 1999; Gibbs, Habeshaw and Yorke, 2000) and are often compounded by increasing demand for research output that will raise their profile in the next research assessment exercise (RAE). This promotes a utilitarian approach to assessment activities which prizes quick returns above pedagogic gains or longer term considerations such as an expected reduction in assessment load once a large item bank has been built. CAA was widely acknowledged to offer the potential of productivity gains in terms of more efficient authoring, publication, delivery, marking and reporting, which was summed up by some as an effective reduction in paperwork:

> …paper based system was very slow and required large resources to keep track of assessment, moderation, results, retries, etc' - Learning technologist LtN4M001).

However it also emerged that where unsupported tutors sought these 'quick wins' without investing in preparative activities such as seeking the advice of experienced colleagues or setting up formative exercises and practice quizzes, the degree of risk taken on all at once could be so significant that colleagues were discouraged from using CAA themselves. This effect was prominent in extreme cases such as student data was loss during an invigilated CAA failure:

> … when the email came round about the [CAA] disaster… some of those colleagues… just went non-linear… how can we possibly have… taken on something which under the most fundamentally obvious things that it had to work under, it fails at the first hurdle? (Tutor AmO5M007)

The effect was less pronounced where the unfavourable outcome was limited to unplanned expenditure of time and effort, for example to recover data or reassure students:

> … this is taking a lot of our time, correcting really quite trivial errors… I've spent a lot of time doing quality checks on in-coming CAA tests. (Learning technologist LtO5M002)

Failure to think through the implications of using CAA can have serious implications:

> … a CAA had been taken and the results had been distributed to [an inexperienced] tutor, the tutor had given them to someone… who… sent them to an external [examiner], including a detailed breakdown of the item analysis of the assessment, which the tutor didn't understand and hadn't intended to go. So the external [examiner] looked at all this and said 'thank you very much, your test appears to be invalid'. (Learning technologist LtO3M001)

Unintended outcomes of this kind threaten the CAA user's credibility. The increased risk incurred by productivity-driven approaches to CAA applications and the braking effect they have on uptake by colleagues represents an extreme case and is shown in the upper half of the paradigm model (Figure 61). It should be noted that this opening of the assessment process to public scrutiny could be regarded as an unintended consequence of CAA which is seldom included in risk registers. Until recently assessment feedback was rarely given, not least because the examination system was ill equipped to provide it. Therefore participants didn't expect feedback and there was no possibility of a debate about academic standards. Now people know it can be done so they take it for granted, not only for formative and diagnostic use but also for summative assessment as well.

Slow burn?

Conversely, where tutors aimed primarily for pedagogical improvements they incurred much less risk and the resultant trajectories were characterised by routine use of small scale quizzes with an initial emphasis on low stakes testing such as formative and diagnostic applications. This sometimes progressed towards higher stakes testing on a larger scale:

> [Their] work on this… [began with] pilot development stages. We [proceeded] to running some Key and Basic Skills tests… with the prospect of widening this out to regular sessions, on-demand and then to high stakes options. (Learning technologist LtS6M002)

This staged, incremental approach was encouraged and supported by learning technologists who recognised the value for tutors of learning to use complex CAA tools in less critical applications. High stakes applications such as examinations were seen by learning technologists very much as risky undertakings which should be the final goal of CAA trajectories:

> [We] did a needs analysis of who wanted to use it… then my team… decided to pilot formative, summative…They wanted to go from there to using it for exams because they had already sort of built a little bit of confidence up. (Learning technologist LtN4F001)

Experienced tutors made similar points:

> For final summative assessment on-line, there are many technical difficulties to overcome and the whole operation is much more complex than a normal paper exam... [it's got to be] planned for. (Tutor AmO5F001)

Staged lower risk trajectories of this kind generally produced productivity gains and consequently diffusion tended to be steady rather than spectacular. Where tutors emulated this approach, they appeared to do so because they perceived a structured, methodical pattern of practice which would protect their investment in assessment materials and which might yield sustainable if modest productivity gains in the medium to long term:

> [We saw that] those that do them get instant feedback on their progress. (Tutor AmO3F001)

[We saw] …higher motivation of students through immediate feedback. Students persist until they get the right solution… (Tutor AMO5O002)

The reduced risk incurred by pedagogically-driven attitudes to CAA use and the accelerating effect this has on uptake by colleagues is shown in the lower half of the model (Figure 61).

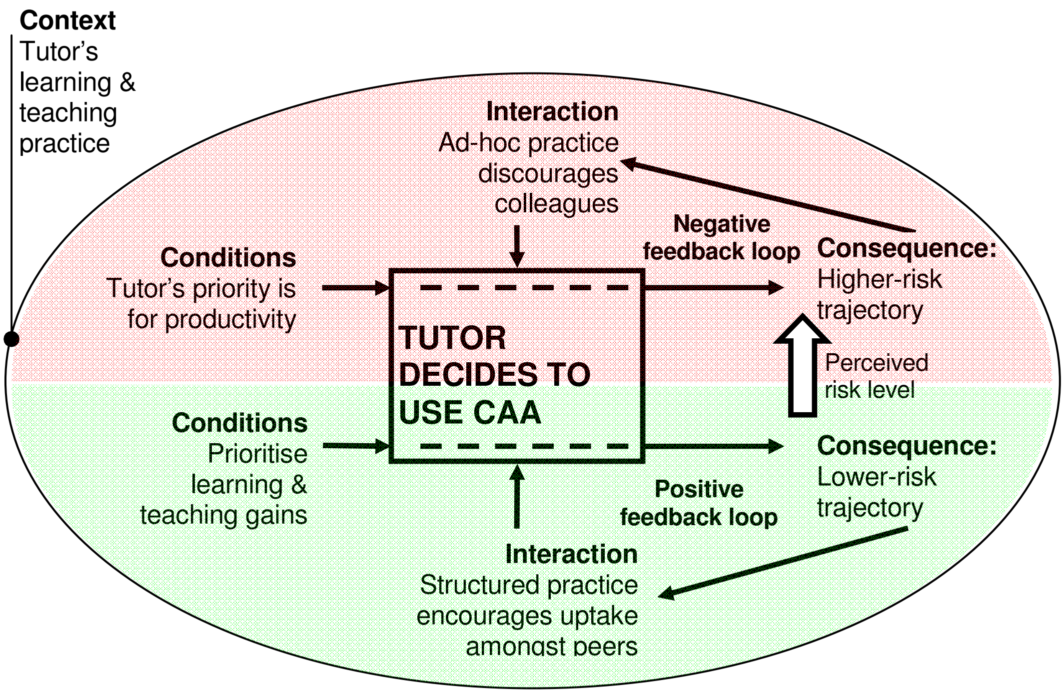


Figure 61- Core dual path theory

Internal risk mitigation

In cases where tutors are already experienced, or are supported by experienced colleagues and learning technologists, this constituted a degree of risk mitigation that could shift what would otherwise have been risky CAA practice into a lower risk trajectory. This mitigating action could be taken by CAA users themselves as 'internal' risk mitigation or by learning technologists on their behalf as 'external' risk mitigation (Figure 62). Elaborations are shown in red.

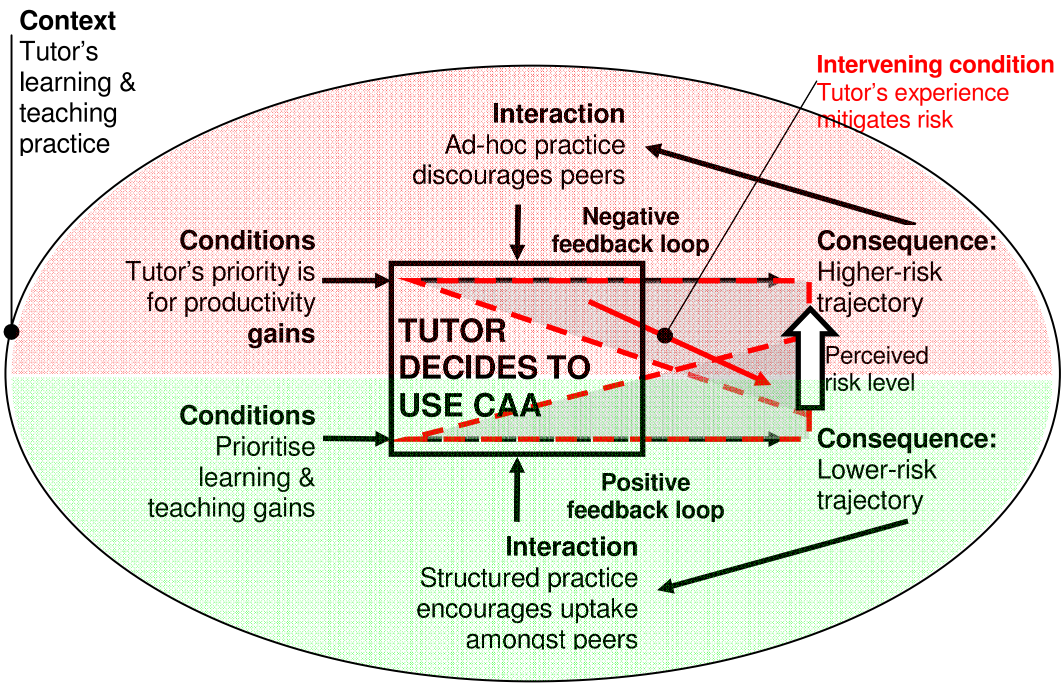


Figure 62- Dual path theory with 'Internal' risk mitigation by tutors

A learning technologist described a case of tutors' previous experience with objective tests as contributing to their own risk mitigation:

> [A school] wants to look for… implementing CBA. Now the interesting thing is… they have a great deal of experience in designing MCQs… they have gone very much for… a high risk trajectory. But they've been very successful at it… I think that's a consequence of their experience that's been obtained from other forms of testing. (Learning technologist LtO5M006)

External risk mitigation

In other cases risk mitigation was performed by learning technologists, who were keenly aware of the underlying fragility of CAA systems ('… the least little thing missed can knock the whole system out' - Learning technologist LtO3F002). An overarching aim of these activities was to make CAA systems easier to use, thus reducing the scope for things to go wrong:

> Ease of use and reliability! We've spent an unbelievable amount of time and effort in making the system foolproof and easy to use... (Learning technologist LtO3M002)
>
> Generally, people don't want [CAA] software [to be more difficult to use than] either Office or the VLE system… (Learning technologist LtN4M004)
>
> Results spreadsheet from CAA was incompatible with our marks spreadsheets resulting in a monotonous manual mark transfer task which inevitably contained transcription errors (Tutor AmN4M002)

A physical aspect of the risk mitigation that learning technologists undertook was to ensure that the integrity of CAA systems, including associated infrastructures, was beyond reproach:

> [They have provided a] 'right first time, every time' application - robust and reliable infrastructure. (Tutor AsO3M002)

These physical measures were often triggered by problems that occurred during high-stakes use where risky practice had exposed underlying weaknesses such as scalability issues:

> … this is its first semester of use and the take-up was so high - so much higher that it led to fairly spectacular problems with it, which… we've now sorted by tuning the system (Learning technologist LtO5M002)

A cultural aspect of risk mitigation by learning technologists was to ensure that appropriate CAA procedures existed and were observed by tutors.

> … we had an incident this year where one of the lecturers… overlooked a procedure which compromised the exam just beforehand and now they have gone off using the system as a result of that oversight. So even though the procedures were in place and he neglected to do one aspect, it has tarnished his view on [CAA]. (Learning technologist LtN2M003)

Risk mitigating measures of both kinds were often taken by learning technologists in a recursive fashion which resulted in a progressively closer fit of risk mitigation to practice:

> … we adapt what we do in the light of continuing experience… (Learning technologist LtO5M006)

Additions to the paradigm model showing external risk mitigation measures taken by learning technologists are shown in red (Figure 63).

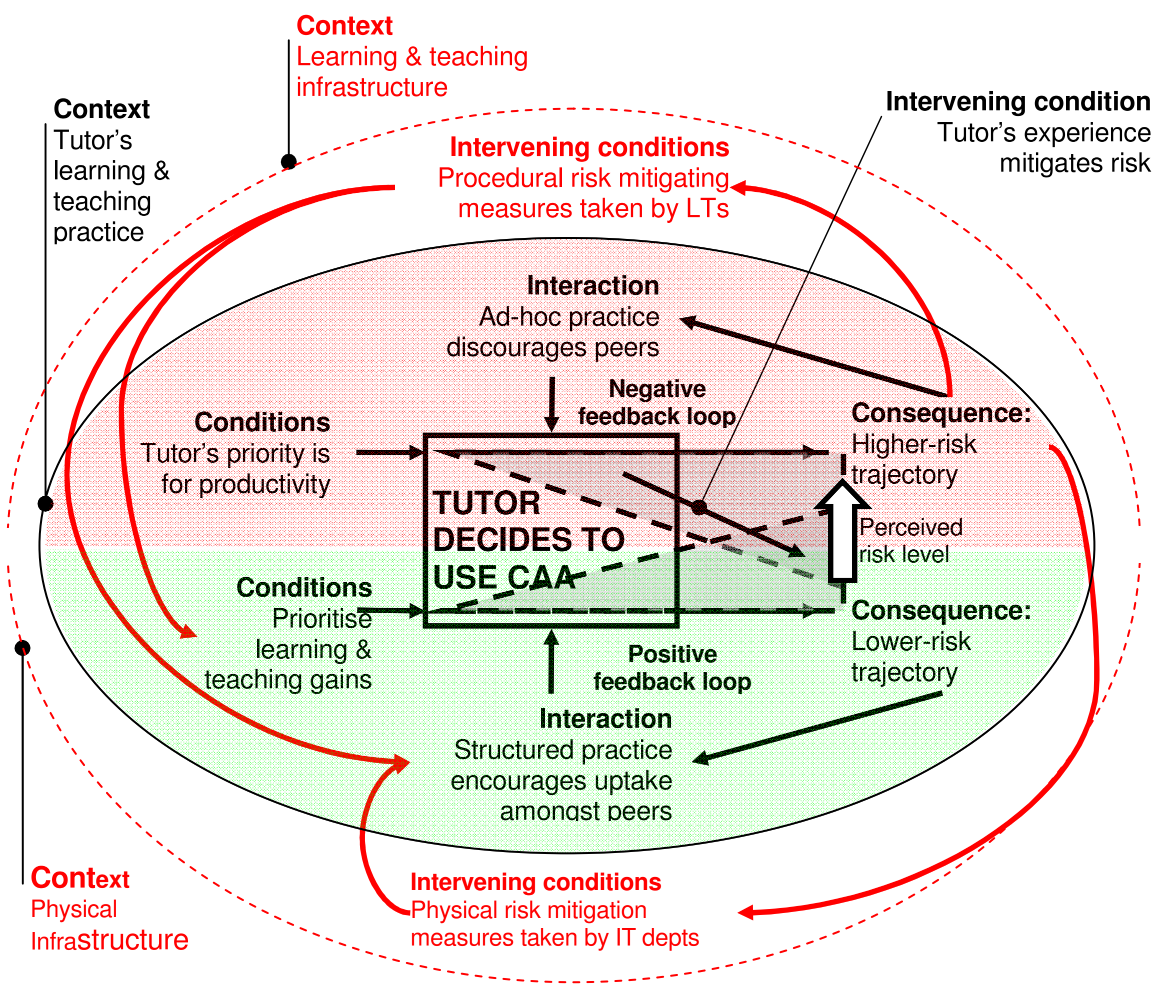


Figure 63- Dual path theory with 'external' risk mitigation by learning technologists

Strategic support

The role of strategic support in legitimating CAA was particularly evident in new universities where centralised organisational structures facilitated the promulgation of CAA policies and procedures:

> … ultimately we have got one [group of] staff who… filter down all the teaching practices [and] they decide what should [happen] and… it gets validated by them: quality procedures and everything… then things come down from the top and CAA practices are embedded... (Learning technologist LtN2M003)

This cultural intervening condition is shown as *institutional validation of existing good practice* and has the direct consequence of increasing uptake by strengthening the remit of the procedural measures put in place by learning technologists. It has the indirect consequence (shown as a dashed line) of increasing uptake by demonstrating the institution's commitment to CAA as a valid tool in the teaching and learning toolkit. The other way in which institutions could drive CAA uptake was by the physical means of providing a *secure funding* and thereby further validating CAA. This has the direct consequence of increasing uptake by strengthening the physical infrastructure and, by virtue of committing real resources, the indirect consequence of increasing uptake by demonstrating the institution's commitment to CAA (shown as a dashed line). Additions are in red (Figure 64).

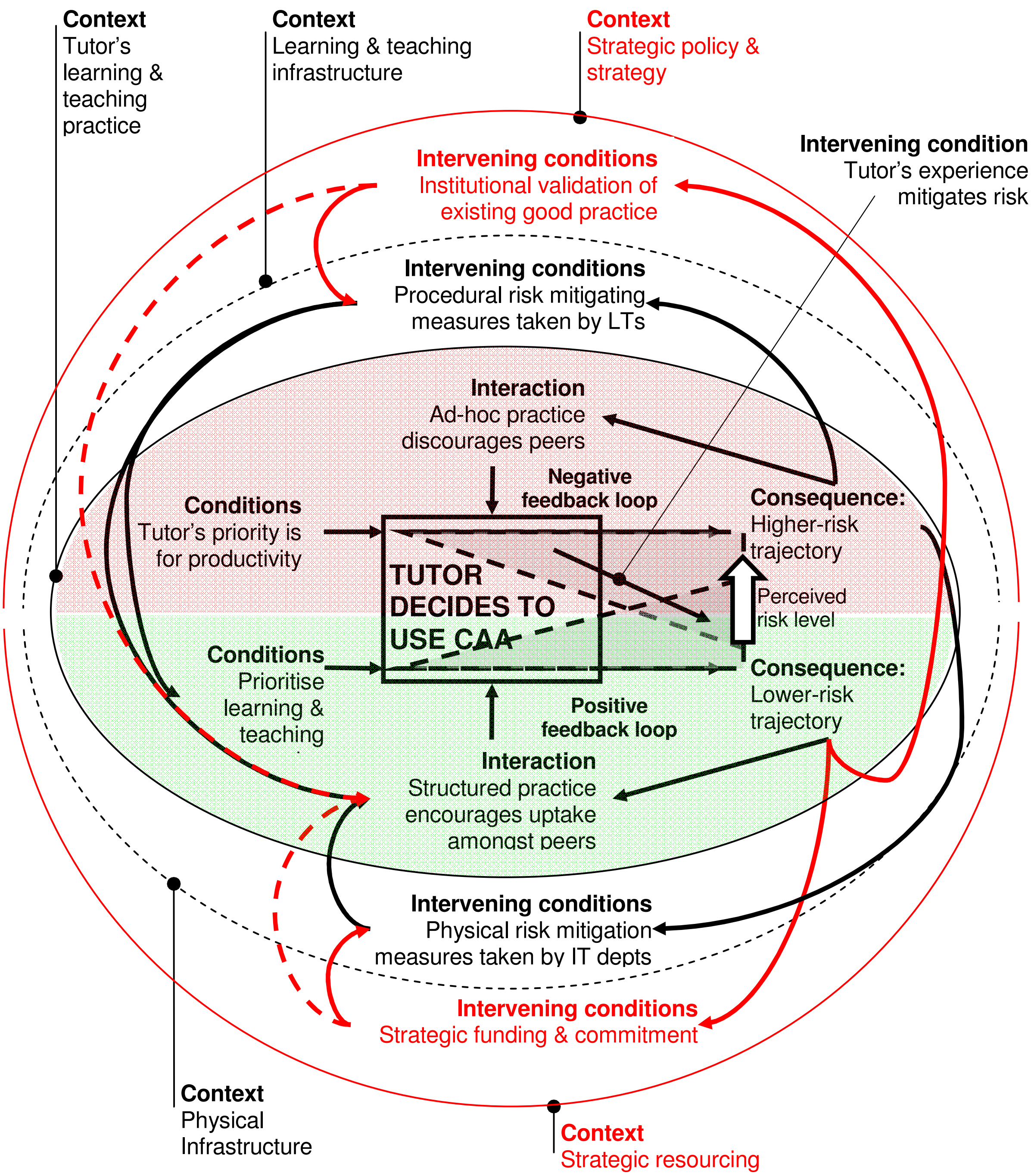


Figure 64- Dual path theory with the influence of strategic support on risk mitigation

6.4.2 PRINCIPLE MECHANISMS DRIVING CAA UPTAKE

The principle mechanisms that emerged from the questionnaire returns and the interviews as driving the uptake of CAA in UK universities were sevenfold. They are described in ascending order of scale using the concentric cylinder model of uptake (Figure 65).

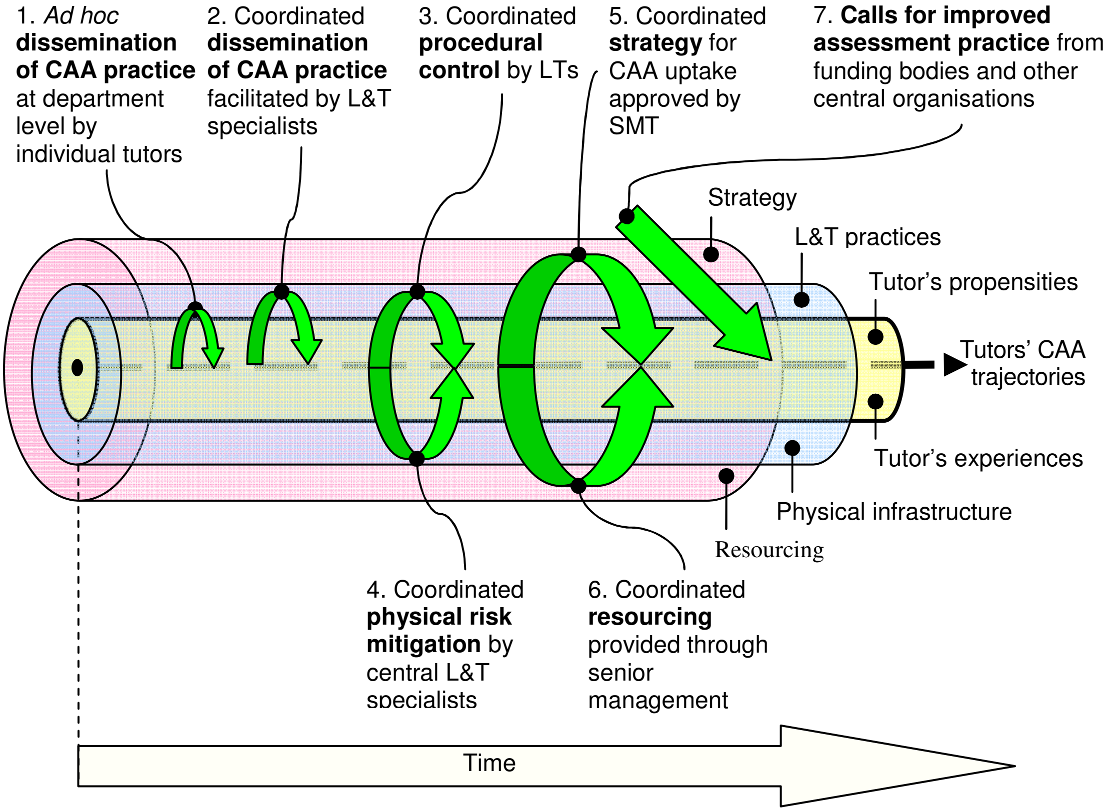


Figure 65- Concentric cylinder model of principle mechanisms driving CAA uptake

It was noted that these mechanisms incur greater latency as they reach higher into the infrastructural and strategic parts of the institution.

1. Ad hoc dissemination of CAA practice at department level

The simplest and most direct form of diffusion is unaided 'word of mouth' dissemination among individual tutors who work together as colleagues. This is recognised by learning technologists and tutors as an effective driver which acts 'horizontally' with respect to other tutors:

> But that's what happens when you get an individual success, suddenly its like everyone's 'right!' and it's everyone at once. Because they say 'I can have some of that, it's obviously working well for him and his students which means it's good for me…' (Learning technologist LtN3F001)

> [A critical driver at the level of the tutor is a] critical mass of people using it. (Tutor AmN6F002)

> Support from someone who has already been through process is a powerful incentive… (Tutor AmN6M003)

2. Coordinated dissemination of CAA practice

One aspect of the model that hinged on mediated support from learning technologists was achieving a 'critical mass' of CAA use:

> Yes, I've a feeling there's a momentum thing here as well, when CAA gains momentum there's a… critical mass. You just can't stop it. It can't be stopped. (Learning technologist LtO3M002)

> I think the community that we have engaged in e-learning has become quite a close-knit little community and they do actually share information between themselves and things don't necessarily go up to these senior levels if its… low impact… and that has sort of perpetuated quite a bit of good practice and stimulated quite a bit of enthusiasm within a relatively small group of people and hopefully others will learn from these enthusiasts. (Tutor LtO5M006)

Some learning technologists in more centralised institutions have a strategic role which permits them to coordinate update by controlling it directly from the top down:

> The route we take is we set targets and we achieve our targets. We don't try to predict - we're not trying to predict where this area might go without steer or direction, we drive the thing, you know? It's not a loose vehicle without a driver at the wheel careering down the hill. (Learning technologist LtO3M002)

> … we've got a huge staff development program running: our team is at the core of that where people are encouraged to come along to train, because they can't use the software if they don't come along and meet us, because they need to meet our team to get the software onto their machine and to get set up on the server. (Learning technologist LtN4F001)

3. Coordinated procedural risk mitigation

In some more centralised universities procedural risk mitigation enforces lower risk practice through institutional *fiat*:

> … we have… policy and procedures… through the committee structures… 'there must be a redundant system available when exams are being run' and 'authors must have done the on-line assessment course'. Its just a necessity basically, because if CAA is being used, then it might as well be… in the nature of the university… our line manager [is] a member of the Senior Management Team. (Learning technologist LtO3M004)

4. Coordinated physical risk mitigation by central L&T specialists

Tutors and learning technologists who had experience of high stakes CAA testing were keen to reduce the chance of something going wrong at a critical time by having institutions invest in suitable physical infrastructures:

> It can't be done on the cheap. Need to have a commitment for a secure central server plus backup and other software which can lock down workstations. So far we are a million miles from this and individual staff don't want to be at the leading edge of this. (Tutor AmN6M004)

5. Coordinated strategy for CAA uptake approved by senior management

Having a member of senior management as an advocate for CAA was cited as crucial by experienced learning technologists:

> When I first started I don't think we had a particularly high profile at all, but I do think people are sitting up and starting to take notice now. The formation of the … DVC's group on CBA for example, is a step in the right direction. We've got someone with real power and influence who thinks this is important and worth getting right. At least we're in a position now where we've got somebody's ear. (Learning technologist LtO5M006)

Efforts to develop integrated managed learning environments (MLEs) at a strategic level were identified as both an obstacle where absent and a driver where present:

> [the lack of integration caused] a lot of hassle for those staff who had been using it in the past successfully [who] were resentful of the CAA system because they had to juggle all these extra bits… That's ultimately what they would like within our university integrated with [the VLE] and [the student records system]… we don't want to have the student records [duplicated in multiple] data bases… we want it to be integrated. (Learning technologist LtN2M003)

The relationship between the uptake of VLEs and of CAA uptake was described by one learning technologists as one where neither could advance more than one step beyond the other:

> I mean I think in the case of Anglebury, that the inertia actually comes in the fact that … that there's a step-by-step process that has to take place between computer-based assessment and e-Learning, I've called it the three-legged race. And the idea is like two contestants in a three-legged race… And OK, we can make progress…but we have to do it in a synchronised way… But I think to reinforce your model, that's the kind of thing that's going on. (Learning technologist AmO5M007)

Tutors have to make their own logistical arrangements for high-stakes summative tests when institutions do not support CAA examinations via the Examinations Office. This presents an effective obstacle to uptake:

> So the way I see it is there are two issues, there's the physical infrastructure which we don't have: probably more importantly is that it's not an easy thing for academics to adopt because they have to do all the organisation and logistical side of things themselves at the moment. (Learning technologist LtO5M006)

6. Coordinated resourcing provided through senior management

There was clear agreement from learning technologists and tutors about the central importance of centralised support and resourcing:

> … when I was at Havenpool, it sort of failed simply because the central services didn't take it on… something about the way it was done without a central team… So there was no central agreement and no institutional drive, so it didn't work, no-one really was sure of who's doing what and why were they doing it anyway, you know? … you need [the institution] to build a solid foundation… (Learning technologist LtN4F001)

7. External influences

Central government funding initiatives may drive uptake by providing an incentive for institutions to implement centralised CAA systems:

> HEFCE have released this x million pounds for eLearning, yes? Across the sector… I'd be very interested to see how many institutions use a part of that money to create a central CAA system... [Its] a government thing, which I guess is another thing in the outer layer of your Arctic Roll model. (Learning technologist LtO3M002)

The pressure from the quality assurance agency (QAA) for more frequent formative feedback should not be underestimated as a driver for uptake at the level of individual tutors:

> … there is an awful lot of pressure on teachers at the moment to provide feedback to students... And that's where…[CAA]… is a scalable method of giving feedback to students as they progress through. And it's an important influence, one of your influences coming in from outside - 'make sure students get feedback'. Well, the QAA are kind of very heavy about [formative feedback] at the moment… the students… go through the semester, they get a semester exam and there's nothing that…could have ever told them how they were doing. (Tutor AmO4M007)

6.4.3 PRINCIPLE MECHANISMS INHIBITING CAA UPTAKE

The principle mechanisms that emerged from the questionnaire returns and the interviews as inhibiting the uptake of CAA in UK universities were also sevenfold and are described in ascending order of scale. They are depicted below using the concentric cylinder model of uptake (Figure 66).

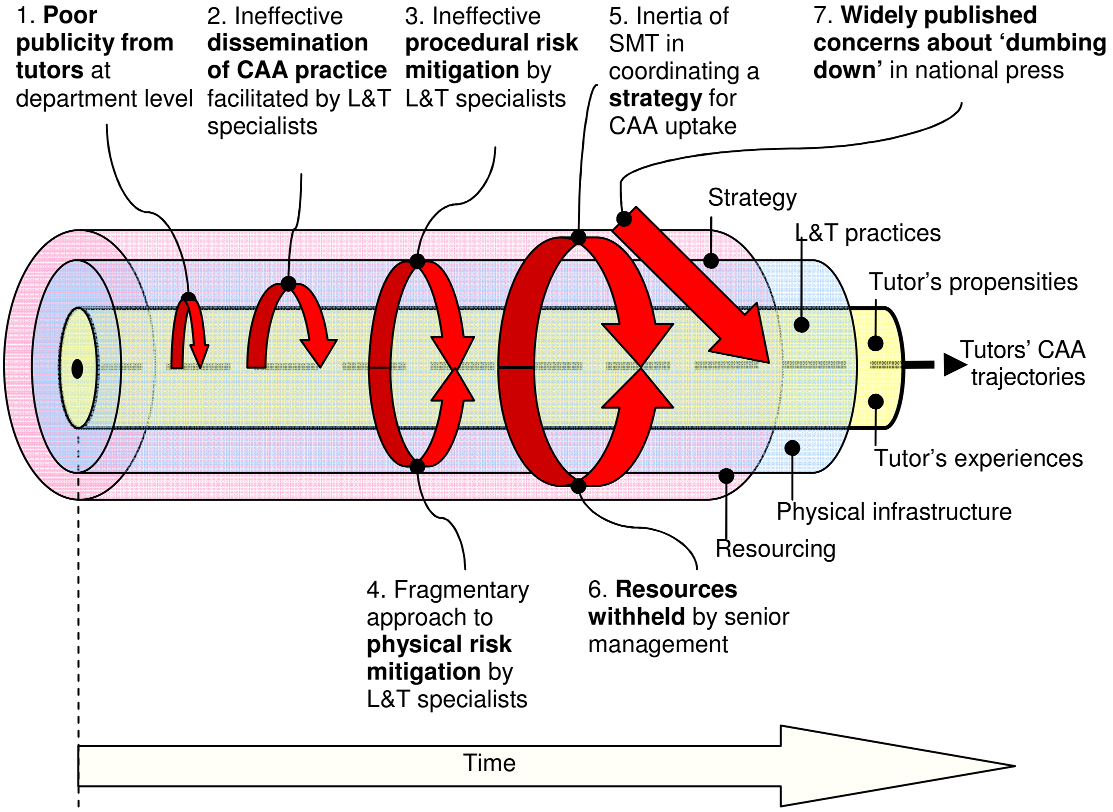


Figure 66- Concentric cylinder model of principle mechanisms inhibiting CAA uptake

1. CAA failures of invigilated tests and fear of these

CAA failures, especially in high stakes invigilated summative tests, have serious consequences for uptake at every level. The consequences are most severe for the tutor because students feel they are under enough pressure already with assessment glitches making matters worse:

> it was not pleasant at all and even worse was that the show goes on: Monday morning at 11 o'clock I was back in front of these 280, on the lecture stage, so - what happens then is, the whole thing snowballs… there were some comments about why they didn't get the solutions even though it was the weekend, as to what we were going to do about it. And… come Monday; you start to get people come up and ask you… 'what's happening, what's happening' and all the time you're trying to fend that off, you're not actually getting on with the solution.

Fears of embarrassment about high-stakes failures appear to result in the formation of informal 'confidentiality bubbles' (Harwood, 2002) that restrict diffusion of these events beyond the boundaries of individual academic departments or groups of learning technologists. The basis of this embarrassment appeared to be a perceived threat to the credibility of tutors and departments:

> … [I think we thought] they'd tell us it was our own fault or something… there's that nagging feeling you get that you forgot to do something vital, like did you turn off the gas? (Tutor AsO4F002)

This *under-reporting of CAA failures* was construed as an amphoteric factor because it contributed to a widespread perception that high-stakes CAA tests were less risky than they really were, which acted as a driver for uptake particularly among tutors who have naïve understandings of technology:

> I think its more of a problem with the staff is their tendency to overestimate their ability to use computers…They think maybe because they can use a wizard in POSH-CAA, that… they're an author for CAA… (Learning technologist LtO3M004)

However, when a failure occurred, it became a very effective brake on uptake because it was so unexpected. Tutors who had been using it abandoned or reconsider the way they use it and tutors who were considering its use found other ways to perform their assessment tasks:

> most people expect things to simply work and … to fail gracefully… people aren't prepared for… when something technical goes wrong, it may not have a 'get you home' mode…(Learning technologist Lt2OM008)

2. Ineffective dissemination of good CAA practice

CAA uptake is vulnerable to attacks from vociferous critics who may have their own agendas based on perceived threats to a department's credibility:

> There's probably a few people [here] who'd love to see one go wrong so they could avoid it, I think and never touch the system again. It's a bit Machiavelli. (Tutor AsO3M002)

The 'quick win' attitude towards CAA is clearly recognisable as a brake on uptake through external examiners' reports to departments:

> [external examiners] realise that there are good ways of using it... but there are other staff who see it as a timesaver and therefore do not put as much time into question development and management as could be put in, therefore tests are not as academically testing as could be - so [external examiners] are not as happy... (Tutor AmN3F001)

3. Ineffective procedural risk mitigation

Procedures which do not yet exist, or which are difficult to interpret, constitute an effective obstacle to uptake. Failures to comply with known procedures can have devastating effects on CAA uptake:

> Thinking about that we had an incident this year where one of the lecturers [who had] been comfortable with using the system but then he neglected a procedure which compromised the exam just beforehand and now they have gone off using the system as a result of that oversight. So even though the procedures were in place and he neglected to do one aspect, it has tarnished [their] view on [CAA]... (Learning technologist LtN2M003)

4. Fragmented approach to physical risk mitigation

CAA systems which are not made easy to use are regarded by both tutors and learning technologists as a significant obstacle to uptake:

> And I do think you are totally right about the infrastructure and operational conditions and one of the things I've introduced… - well it would take maybe 10 minutes if you were really slick… and in that 10 minutes you could have covered a chapter in the syllabus. So only the really keen ones did it. So I think the infrastructure, yes, is a crucial thing there. Yes, ease of use, that's right, exactly - it is, yes. (Learning technologist AmO5M007)

The difficulty of load-testing CAA systems emerged as a significant obstacle to uptake:

> If you are looking at the CAA system… and… you have say 200 students on a module … just to test the software would be nigh on impossible… well you just have to hope [it doesn't go wrong] don't you? (Learning technologist LtN2M003)

5. Institutional strategy shortfall

The inertia associated with institutions approving CAA applications acts as a brake on innovation by leaving little time for busy tutors to change their practice:

> Universities are so slow to move anyway… and also… if you take these [serial] time [delays], suddenly you've got a very short timescale [for the tutor to implement CAA applications. Because there's so much [else] going on. (Learning technologist LtN3F008)

As a complement to institutional inertia, one learning technologist cited ongoing organisational change as being itself an obstacle to innovation in assessment:

> And it's exactly an inertia of change which is a ridiculous thing to say, but because we're changing we can't do a lot of things. (Learning technologist LtO5M006)

A learning technologist identified failure to implement an overarching strategy at the institutional level as a significant brake on uptake:

> [A science department] picked up on it and they want to use it next year … and the other departments have seen what we have done with it and its internal and external strategy or procedures that have come down from the hierarchy to govern it. (Learning technologist LtN2M003)

Tutors and learning technologists wishing to use CAA in summative applications are often obliged to wait for institutions to give permission:

> Also it is likely to reinforce the learning and teaching benefits because that's validated by the institution standing behind it. What is interesting is when they're at the point they believe they want to buy into it… most institutions have somebody or

> a few people with good experiences. And everybody kind of thinks it going to be a jolly good idea…but nobody's got a lot of time to do it because nobody's given them permission to do it at university level. (Learning technologist LtN3F001)

6. Resources withheld by senior management

According to learning technologists, the pace of organisational change was sometimes cited by senior management as a good reason for not investing in institutional CAA infrastructure such as large workstation areas. This was said to act as a brake on uptake:

> What you're talking about is not investing a lot of money in a large, or several large 200-seat computer clusters. I have a sneaking suspicion here that the actual driver behind thus is that the University doesn't like spending money. (Learning technologist LtO5M006)

A reluctance on the part of senior management to invest in infrastructure until uptake had increased to the point where it was justified was said to compound the lack of suitable workstation areas as a brake on uptake:

> … I've been told that we won't get infrastructure unless we can demonstrate there's a demand. The problem is you can't stimulate the demand unless you can demonstrate there's an infrastructure in which it can work. So its one of these sorts of circular arguments, where it's very difficult to know how it's going to be taken forward. (Learning technologist LtO5M006)

7. Concerns about 'dumbing down'

Fears of 'dumbing down' inhibit uptake by affecting the perceptions of external stakeholders such as employers regarding the use of CAA in higher education. This may have discouraged some departments from using CAA:

> … external factors… may have a knock on effect for the university if it is using CAA if there a perception by the employers that it's no good and they won't employ people because of this then they might stop using it and switch to more traditional assessment methods. (Learning technologist LtN2M003)

6.5 Metrics for uptake

There were few comments about the metrics of uptake which were presented to the phase 3 respondents. Most of the feedback was favourable and acknowledged that the metrics reflected real patterns of uptake. However, one senior academic pointed out that a metric of uptake that should be considered was the degree of dissemination achieved outside the original institution. This was added to the scheme of metrics (Figure 67).

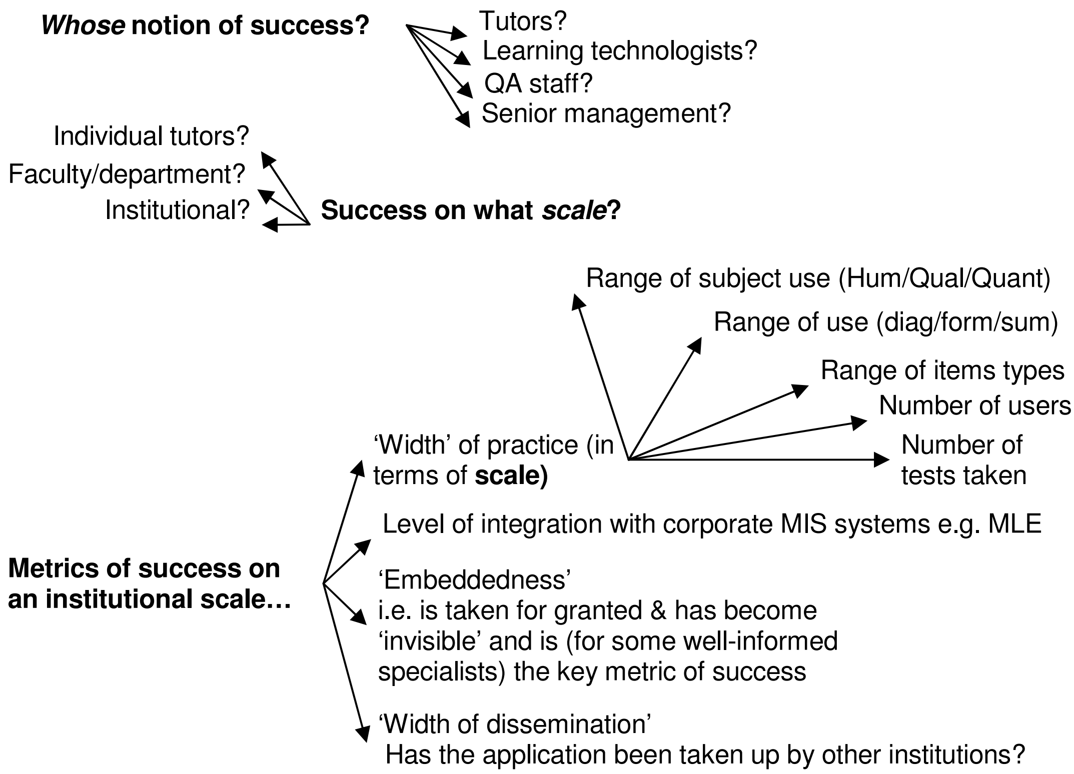


Figure 67- Updated metrics for successful implementation

6.6 Chapter summary

This chapter was the third part of the data theory section. It described a third and final round of data collection (section 6.1) and analysis which was used to validate the theory. Where respondents suggested extensions and exceptions to the theory they have been incorporated during open and axial coding (sections 6.2 and 6.3) and the theory was presented through selective coding (section 6.4). The emergent theory dual path uptake was confirmed by CAA experts as a reasonable explanation for the patterns of use seen in UK universities.

Enhancements were made to the scope of the paradigm model by adding infrastructural and strategic elements which had been left off the version presented to the phase 3 respondents for the sake of clarity. The principle mechanisms driving and inhibiting CAA uptake were confirmed and shown more clearly in diagrams. The examples of typical tutor CAA trajectories were well received and it was felt that little could be added to make them clearer or more comprehensive, apart from the addition of the 'twist or stick' trajectory described by a tutor.

The next chapter is the discussion section where findings are discussed in context with the original research questions. Comparisons are made with relevant literature and suggestions made for extending the scope and validity of the theory.

7 Discussion

Chapter 7 is arranged as a narrative which traces the progress of the research using the original sub-questions and research questions as a framework (section 3.1). The outputs of the research, which are the dual path theory of CAA uptake and the three models associated with it, are triangulated with the results of the 2003/4 survey and then compared with the findings of the 1999 and 1995 CAA surveys. The findings are summarised and aligned with other theoretical perspectives in the literature shown as box IV in bold below (Figure 68) which leads to some recommendations for better managing uptake and securing the benefits of CAA where appropriate.

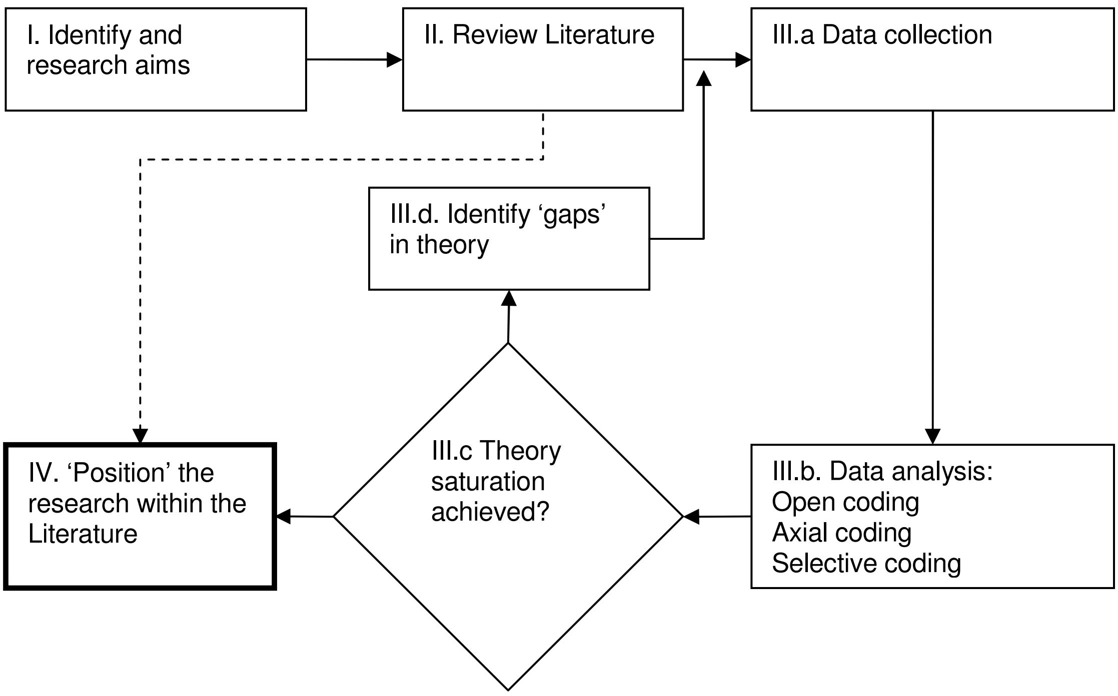


Figure 68- Research process workflow (adapted from Harwood, 2002 p. 69)

This is followed by some reflections on the suitability of the methodology used in the research. The chapter concludes with a summary of key findings and some suggestions for following up and extending the research.

7.1 Answering the research questions

The research comprised a study of the mechanisms underlying the uptake of CAA in higher education in the UK. In line with the account of GT methods given by Strauss and Corbin (1998a), it progressed through several iterations of theoretical sampling and emergent theory development before the research findings emerged in the final selective coding phase as a substantive theory of dual path uptake.

The original research question was why, given the *prima facie* advantages, CAA uptake is not higher in UK universities. This raised a second question of what can be done to secure the benefits of CAA where appropriate. The research problem was framed as an investigation into CAA uptake mechanisms with the aim of producing a model of CAA uptake. A set of sub-questions were posed to focus the investigation on aspects of CAA that appeared to underlie the problem of understanding CAA uptake (chapter 3). The research findings are traced here in a bottom-up fashion (Figure 69).

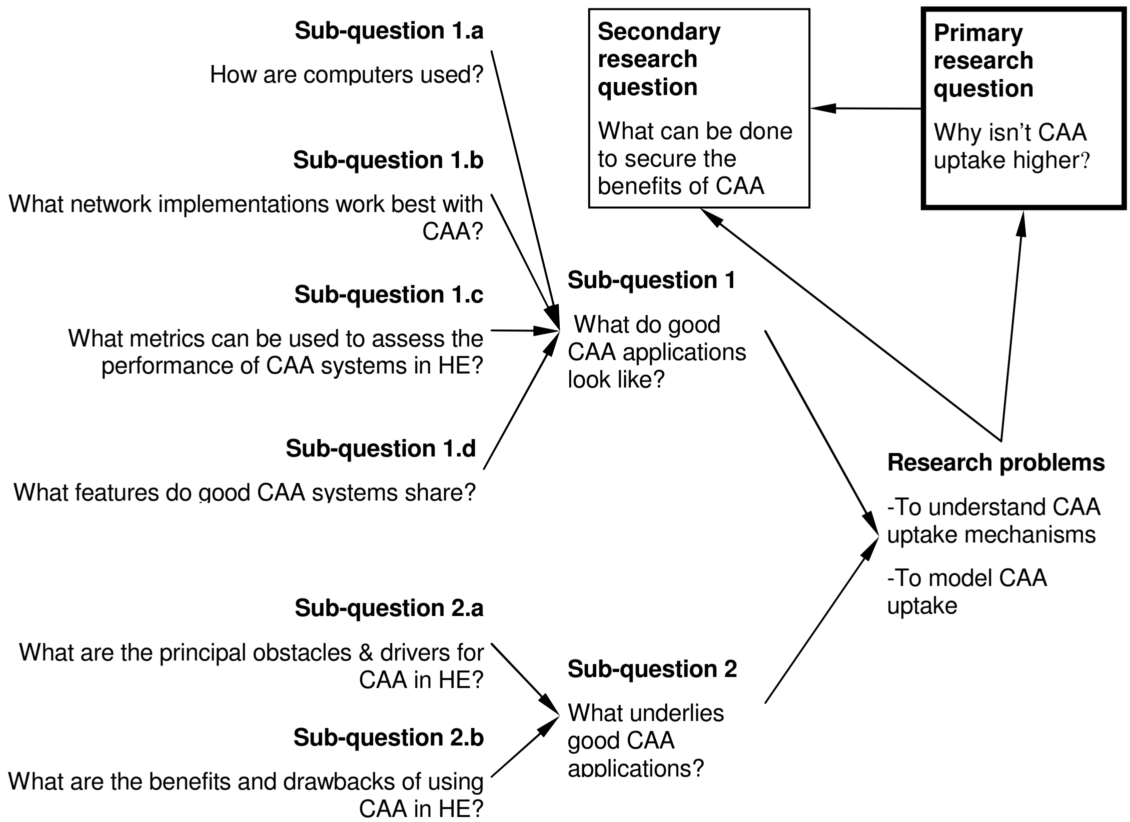


Figure 69- Links between sub questions, research problems and research questions

The sub-questions are discussed in relation to factual outputs from the 2003/4 UK CAA survey and the central theory of CAA uptake. Patterns of behaviour predicted by the dual path model are put in context with the 2003/4 survey. The primary research question of why uptake is not higher is addressed in the context of raw data from the 2003/4 survey and the question of how to better secure the benefits of CAA is related to the literature of project risk management.

7.1.1 SUB-QUESTIONS RELATED TO FACTUAL OUTPUTS OF RESEARCH

Sub-question 1 had to do with identifying the characteristics of good CAA applications. Many respondents commented on the significance of well resourced computer infrastructures, particularly regarding the importance of large well managed workstation clusters for invigilated CAA tests. A premium was placed upon centrally-managed CAA systems which were available institution-wide and the reliability and resilience of which could be taken for granted.

CAA tests were largely delivered over campus intranets with some usage over the internet and again centrally-managed data networks were preferred.

Metrics of success were developed during the research (Figure 70). These metrics represent a varied landscape of achievement so that making judgements of 'success' is a complex and potentially contentious exercise.

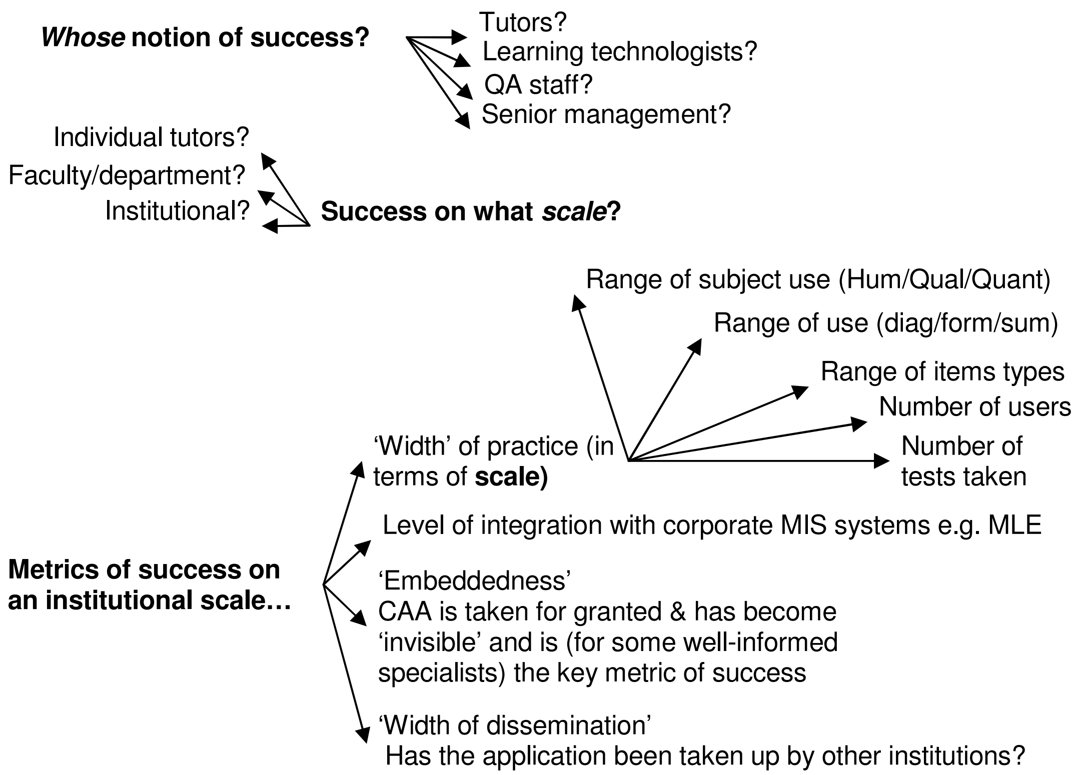


Figure 70- Final scheme of metrics for successful implementation

Regarding the characteristics of 'good' CAA applications, it was apparent that there was no single 'right' way to do CAA because criteria for success depended upon the perspective of the person asking the question. They emerged as multi-dimensional and context dependent (Figure 70). However there was clear agreement that the kind of CAA practice which was most likely to be emulated by colleagues was innovation at the individual level characterised by apparent ease of use which was likely to be credit-bearing and innocent of any malfunction.

Sub-question 2 was concerned with identifying the underlying characteristics of good CAA practice. The two lines of inquiry pursued with the aim of understanding what constitutes good CAA practice were to explore how different factors act as obstacles or drivers, and under what conditions they may change from one to the other. The final scheme of obstacles and drivers which emerged from the research comprises 26 interdependent factors which can be characterised as predominantly cultural or operational. These were disposed as an outer strategic shell, an intermediate infrastructural layer and an inner core comprising the tutor's personal characteristics in terms of propensity and experience. The full scheme is listed in appendix F. Principle discoveries at this level included the ambiguous ('amphoteric') nature of some factors which under some conditions switched from being drivers to effective obstacles or *vice versa* and the role of learning technologists in mitigating the risk taken on by inexperienced tutors when undertaking high stakes CAA testing.

The balance of benefits and disadvantages perceived by individual tutors emerged as crucial to their decisions about whether or not to use CAA but it was less obvious that this also had a significant influence on the pattern of uptake including the degree of risk taken on. In particular, the availability of CAA tools made it possible for tutors who were looking primarily for productivity gains to adopt *ad hoc* styles of practice which were intrinsically riskier than more linear approaches.

7.1.2 FINDINGS MAPPED TO THE RESEARCH PROBLEM

These findings from the investigation were fed back into the research problem which was to understand the mechanisms underlying CAA uptake and thereby to model CAA uptake. A detailed description of the substantive theory of dual path uptake and models of CAA uptake developed in conjunction with it were described earlier (section 6.4). The original research question was 'why isn't CAA uptake higher' and this is addressed (section 7.4) after a discussion of the theory's validity in the context of the 2003/4 national survey (section 7.2) and other research (section 7.3).

7.2 Triangulating theory with 2003/4 UK survey

I had access to raw data from the 2003/4 surveys which was not the case with the 1999 or 1995 surveys, where only published analyses were available (Bull, 1999; Bull and McKenna, 2000; Stephens and Mascia, 1997). The non-textual data in the 2003/4 questionnaire returns were not analysed in detail until the end of the study for two reasons: firstly to avoid contaminating the GT analysis with preconceived ideas about patterns of uptake and secondly to focus the analysis on testing the predictive power of the substantive theory against patterns of uptake found in the non-textual data. Chi-square tests were used to compare expected figures with actual data as a test of whether differences were significant.

7.2.1 THE 2003/4 SURVEY SAMPLE

According to Higher Education and Research Opportunities, there are 197 higher education institutions in the UK of which 161 are universities with their own degree awarding powers (HERO, 2005). UK universities are divided almost equally between pre-1992 or 'old' universities and post-1992 or ‘new’ universities. Old and new universities were equally represented in the 2003/4 UK questionnaire although a few more learning technologists worked in new universities and more QA staff worked in new universities (Table 39). These differences did not appear significant enough to stand in the way of making valid comparisons between tutors’ practice in old and new universities. A lower proportion of 2003/4 respondents were tutors compared with 1999, which may reflect a rise in the numbers of support staff working with CAA (χ^2 P-value<0.05).

Questionnaire responses from:	1999	2003/4		
		New universities	Old universities	2003/4 totals
Tutors	580 (77%)	52	52	104 (67%)
Learning technologists[3]	150 (20%)	22	16	38 (25%)
Quality assurance staff	23 (3%)	2	7	9 (6%)
Totals	753	76	75	151 (100%)

Table 39- Breakdown of job function in old and new universities

7.2.2 SUBJECT DIFFERENCES IN THE 2003/4 SURVEY

The theory predicted that tutors of mathematically-based subjects would be over-represented for both old and new universities because their assessment activities would present fewer obstacles in terms of fitness for purpose. Objective testing techniques have been used in those subjects for many years (Bull and McKenna, 2004; Warburton and Conole, 2005). The mathematically-based subjects indeed appeared to be significantly over-represented in both old (P<0.0001) and new (P<0.0001) universities compared with the social sciences and the humanities. Old and new universities did not appear to differ significantly in terms of subject representation (Table 40) which supports the theory.

Questionnaire responses from:	new universities	old universities	No. responses expected if subjects equally represented
Tutors of maths-based subjects	37	33	17.3
Tutors of social science subjects	15	16	17.3
Tutors of humanities subjects	0	3	17.3
Totals	52	52	52
χ^2 P-values	<0.0001	<0.0001	

Table 40- Breakdown of subject specialisms in old and new universities

A comparison was made between the 1999 and 2003/4 surveys of the number of tests delivered in different subject types, which meant excluding a large number of tests reported by learning technologists who often left out the subject name. Because there were so few humanities respondents, their responses were combined with those of social scientists to form a ‘discursive’ grouping (Table 41). It can be seen that little has changed since 1999 when most tests were delivered in mathematically-based subjects, although the number of tests reportedly

[3] No distinction was made between learning technologists and staff developers in the 2003/4 survey analysis so these have been combined in the 1999 data.

delivered has increased significantly. This apparent increase may reflect a real increase, or it might be an artefact of the 2003/4 sample's apparent skew towards CAA users, whereas the 1999 survey was targeted at users and non-users alike (Bull, 1999).

Tests delivered differences	1999	2003/4
Maths-based subjects	215 (72%)	1088 (87%)
Discursive subjects	83 (28%)	165 (13%)
Totals	298 (100%)	1253 (100%)

Table 41- Breakdown of CAA tests by subject specialisms in 1999 and 2003

7.2.3 COMPARISONS BETWEEN OLD AND NEW UNIVERSITIES

In order to triangulate the theory of uptake with the 2003/4 survey, comparisons were also made between old and new universities on the grounds that the theory predicted differences in assessment practice. In particular it was predictable that pressures for RAE performance would promote a time-saving attitude towards CAA in old research-led universities, whilst the emphasis in new teaching-led universities would be more on the use of CAA for improving student learning. Comparisons of key parameters of CAA practice such as assessment type and group size are tabulated against the figures expected if there were no differences between old and new universities. If old and new universities do not differ significantly (the null hypothesis), CAA assessment practice as reported in the survey should be roughly similar: if not then an explanation for the difference should be sought (Rowntree, 1981 pp. 151-153). Chi-square tests were used to test whether differences were significant (Table 42).

	No. of CAA users	No. of summative tests reported	No. of summative tests expected	No. of non-summative tests reported	No. of non-summative tests expected	No. of invigilated tests reported	No. of invigilated tests expected	No. of productivity citations	No. of productivity citations expected	L&T cited as reason for using CAA	No. of L&T citations expected	No. of large groups reported	No. of large groups expected	No. of L&T funding citations	No. of L&T funding citations expected	No. of inheritance citations	No. of inheritance citations expected	No. of self-reported enthusiasts	No. of enthusiasts expected	No. of assertions that VLEs drive uptake	No. of 'VLEs drive uptakes' expected
Old universities	75	303	234	507	654	76	71	14	8.5	12	8.5	26	25	11	11	4	5	11	11	30	38
New universities	76	168	237	810	663	67	72	3	8.5	5	8.5	25	26	12	12	6	5	12	12	47	39
Totals	151	471	471	1317	1317	143	143	17	17	17	17	31	31	23	23	10	10	23	23	77	77
χ^2 P-values		<0.0001		<0.0001		<0.5		<0.01		0.09		0.78		1		0.53		1		<0.07	

Table 42- Comparison of old and new universities in terms of CAA practice

7.2.4 QUICK WINS?

If, as reported by respondents in old universities, RAE pressures reduce the time available for learning and teaching activities then one might expect 'time saving' *ad hoc* attitudes towards CAA which may be observable in the 2003/4 survey data:

> Where's the payback? Look at the impact of the RAE on a department; then consider the impact of implementing CAA…which will best aid a promotion case? Another research paper… or the writing of a 'good' CAA which only the student will see as being 'good'? Did anyone ever get a pat on the back for writing a really probing exam? (Learning technologist LtO5M001)

One might therefore see tutors in old universities citing 'productivity' more frequently as a reason for using CAA, or delivering more summative and invigilated tests. The number of summative tests reportedly delivered in old and new universities was compared. Summative test instances reported by tutors were aggregated with those reported by learning technologists after a check by institution was made to ensure that the same activities were not being reported twice.

A chi-square test showed that summative test frequency is significantly different in favour of the model's prediction ($P<0.05$) although the number of invigilated tests reportedly delivered in old and new universities was not significantly different ($P=0.5$). However it should be born in mind that large scale high stakes testing is seen as the riskiest CAA activity (Harwood, 2005a; Harwood and Warburton, 2004) and this may inhibit uptake for invigilated use despite the apparent greater tendency to *ad hoc* CAA practice in old universities.

7.2.5 SLOW BURN?

New universities are often referred to as 'teaching-led' and are said to put a greater emphasis on learning and teaching:

> … staff at older universities are more likely to perceive themselves as 'researchers who teach', as opposed to post 1992 institutions, where some staff view themselves primarily as teachers who may or may not engage in research. (Clegg, 2005)

One might expect to see tutors in post-1992 universities citing learning and teaching more frequently as a reason for using CAA and delivering more formative tests. A chi-square test showed reported non-summative test frequency to be significantly higher in new universities ($P<0.05$) which supports the model's prediction.

Productivity benefits were more frequently cited as the main reasons for starting CAA use by tutors in old universities (Table 42Table 1). A chi-square test indicated that significantly more non-summative tests were delivered in new universities (P<0.05) which supports the theory. Although there are fewer than five cases in one of the cells, the conclusion is reasonable on statistical grounds because there are more than five cases in the expected values (Bryman & Cramer, 1997 pp. 122-123; Rowntree, 1981 p. 152).

In contrast, learning and teaching benefits, particularly the ease with which formative tests can be created and delivered, were more frequently cited as the main reasons for starting CAA use by tutors in new universities (Table 42). However a chi-square test showed that this difference was not significant at the P=0.05 level (P=0.08) which indicated that the null hypothesis could not be rejected with confidence. Pressure from management was not cited as a reason to use CAA by tutors in old universities whereas it was cited by four tutors in new universities as the main reason for using CAA.

7.2.6 THE INFLUENCE OF VLES ON THE UPTAKE OF CAA

The theory predicts that devolved organisations will experience less pressure for the uptake of CAA on the grounds that less centralised data systems militate against 'one size fits all' VLEs and centralised CAA systems. If this is so then respondents in old universities should cite VLEs as a driver for the uptake of CAA less frequently than respondents in new universities (Table 42) and this is born out by the survey (P<0.05).

7.2.7 POSSIBLE CONFOUNDING FACTORS

It was possible that other differences in the data that were responsible for the observed differences between tutors' practice in old and new universities. Possible confounding factors tested for in the 2003/4 survey data were differing incidences of:

- large groups
- funding for learning and teaching (L&T)
- inheriting a CAA application from a colleague
- enthusiasts

An arbitrary definition of a 'large' group as 'more than 100' was adopted because there seemed to be a natural grouping above and below that point in the survey data. The incidence of groups larger than 100 was assessed directly from Q.19 in the 2003/4 survey ('group size') and the incidence of enthusiasts, inheritance and L&T funding was obtained from respondents answers to Q.14 ('reasons for using CAA'). The frequencies of these four factors were compared in a similar way to the tests described earlier in this chapter. Chi-square tests were conducted which showed that the incidences of large groups (P<0.8), L&T funding (P=1), Inheritance (P=0.53) and the number of enthusiasts (P=1) did not differ significantly in old and new universities. On this basis the differences found between old and universities with regard to CAA practice could not be attributed to any of the four confounding factors.

7.3 Comparison with findings from other surveys

The UK survey conducted by the CAA Centre in 1999 aimed to identify factors working as obstacles and drivers, pedagogical benefits and limitations, the current nature of CAA testing, the kind of support available and what policies governed the use of CAA (Bull, 1999). These aspects are used as headings in this section.

7.3.1 CRITICAL FACTORS

Cost in terms of both personal time and the expense of CAA software and its associated infrastructure was identified in 1999 and 1995 as the most significant obstacle to uptake and this continued to be so with 60% of 2003/4 respondents citing it. The importance of technical and pedagogic support was cited by 46% of 2003/4 respondents The steep learning curve associated with CAA practice was identified in 1999 as an effective brake on uptake and this was cited by 24% of 2003/4 respondents. Inherent conservatism was a persistent and pervasive obstacle cited at the levels of institutions and individual tutors (21%). The difficulty of constructing objective items that reliably assess higher-order learning outcomes (HLOs) was less evident in the 2003/4 survey (18%) but this may be an artefact of the sample which was heavily skewed towards mathematically based subject specialists.

Of the 20 factors identified in 1999 as obstacles, 90% could be classed as cultural compared with the 2003/4 survey where of the 30 critical factors, 17 were cultural and 13 were operational in nature (Appendix F). This is supported by an analysis of the number of citations for these factors which showed 1246 references to cultural factors compared with 889 references to operational factors. The null hypothesis that operational and cultural factors are equally important (according to the number of references) can be rejected with confidence (χ^2 P-value < 0.05).

In Zakrzewski and Steven's (2000) risk register, one third of the factors identified could be categorised as cultural and the other two thirds as operational. A recent update (Zakrzewski and Steven, 2003) included some changes to the risk schedule but the balance was largely unchanged. Hambrick's (2002) Delphi study identified 37 critical factors said to govern the large scale uptake of summative CAA in the US K-12 school system, which were split almost equally between cultural and operational factors. These factors align well with the findings of this research and are listed in Appendix E.

Operational factors might be expected to become less significant in time because many are associated with technologically-based risks which tend to diminish as technologies mature (Moore, 1999). For example, the low bandwidth and poor reliability of network connections was prominent in the two earlier UK surveys, in Zakrzewski and Steven's risk register and in Hambrick's Delphi analysis, but was infrequently cited in the 2003 (8%) and less frequently than that in 2004 (5%). This is in line with observable improvements in network technology such as ADSL WAN connections and the replacement of copper with optical fibre. Much the same argument could apply to workstation reliability and performance requirements.

However cultural factors appear to be both pervasive and persistent, recurring through time and in quite different circumstances. For example, Hambrick identified the following cultural factor as critical in the uptake of summative CAA:

> Is the purpose of moving towards online assessment efficiency or cost, or [is] the purpose to support evaluation research and new ways to teach and learn? (Hambrick, 2002 p.91)

It may be recalled that this is the central issue in the dual path theory of uptake, although the consequences of this choice are not described in Hambrick's thesis.

Respondents in the 1999 survey described a credibility gap between what CAA proponents promise and what respondents thought could be delivered. This seemed to have changed little in the 2003/4 survey where several respondents cited it directly and 40% of tutors teaching discursive subjects found CAA unfit for some purposes, compared with 39% of tutors teaching mathematically-based subjects. One might expect the discursive figure to be higher than for mathematically-based subjects but this could be an artefact of the sample being skewed towards CAA users.

7.3.2 THE CURRENT NATURE OF CAA TESTING

In 1999 most CAA tests were web-based, with a large fraction of respondents delivered using closed networks and a small percentage using paper-based optical mark reading (OMR). The 2003/4 survey revealed an acceleration of the trend towards web-based testing with only a few instances of tests being delivered on closed networks, although in most of those cases the software used was browser-based.

The 1999 survey found that 'CAA is overwhelmingly used for summative purposes' (McKenna and Bull, 2000 p. 25), but in the 2003/4 survey only 26% of assessments were summative of which 30% were invigilated. This means only 8% of all the CAA tests reportedly delivered in

2003/4 were invigilated which appears to represent a substantial shift towards formative or diagnostic use.

In 1999 QA staff identified few enabling factors, which indicated a largely negative perception of CAA (n=23). This appeared to have changed somewhat by 2003/4 with 57% of QA citations identifying drivers compared with 43% which identified obstacles to uptake. This may indicate growing acceptance among QA staff for the use of CAA in some higher education assessment applications, but the sample is very small (n=9).

7.3.3 THE KIND OF SUPPORT AVAILABLE FOR CAA TESTING

The 2003/4 survey repeated the question asked in 1999 regarding the provision of support for CAA. There appeared to be significant growth in provision of CAA support through central units which was cited by 68% of 2003/4 respondents, although no figure for this was found for comparison in the 1999 literature. Of these 10% said that CAA support was also provided at departmental or faculty level. There appeared to be a trend towards formal recognition of CAA by identifying individuals as ‘CAA Officers’ or ‘CAA Managers’ (cited by 8% of 2003/4 respondents) although there are no 1999 data for comparison.

Wilson and Stacey’s (2004) summary of staff development levels showed that institutions align staff development initiatives to perceived levels of ‘change readiness’ which resonates with the widely held perception that staff development for diffusion of innovation needs to be delivered 'just in time' and be relevant to local contexts. This agrees with a key finding of this research that the timing and quality of training and support for CAA using tutors play an essential role in mitigating an observed tendency to underestimate the complexity of CAA.

7.3.4 POLICIES GOVERNING THE USE OF CAA

Stephens & Mascia (1997 pp. 26-27) identified the importance of making CAA a fully integrated part of existing assessment procedures rather than an afterthought and this was restated by Bull (2001). The significance of an institutional CAA strategy with policies and procedures that have been approved at strategic level emerged as a key driver for the uptake of CAA. Putting such documents in place, however, seemed to be a lengthy and difficult process that required a senior management champion. The survey revealed little intent to integrate codes of CAA practice such as BS7988 into institutional policy and procedure documents, although this may be something that is happening ‘behind the scenes’ (Shephard et al., In press). These documents are not always clear and easy to interpret which was cited as an effective obstacle: ‘Interpretation of awkward best practice guides such as BS7988’ (Learning technologist LtO3M002).

7.4 Change and CAA

The research has highlighted the dynamic nature of the factors governing CAA uptake. This section addresses the research questions in the context of four kinds of change that have emerged as critical to uptake. These are taken from the literatures of diffusion, organisational change, project risk management and evolution.

7.4.1 DIFFUSION AND CAA

An aim of the research was to apply an understanding of why CAA uptake lags the expectations of enthusiasts and learning technologists to the problem of how to secure its benefits where it was fit for use and not already in use. The research findings could be very briefly summarised as showing that tutors won't use CAA until it's easier than any alternatives and once they start using it their motivations and perceptions of risk play a central role in the outcome of their practice. If inexperienced tutors are motivated primarily to secure productivity gains - especially credit-bearing 'quick wins' - they are more likely to adopt unmitigated approaches which can fail in various ways. Once their colleagues find out about such failures they are most unlikely to use it themselves. On the other hand if tutors are aiming more for pedagogic improvements their practice will be lower risk and they will 'self mitigate' by learning the tools and their limitations before attempting credit-bearing applications. However, institutions can manage the elevated levels of risk incurred by productivity-driven approaches to CAA use.

This scenario resembles the hiatus in uptake between early adopters and the early mainstream described by Moore (Figure 71) who attributes this to the unwillingness of the early majority to work with applications that are difficult to use (Moore, 1999). This 'chasm' has been widely adopted as a metaphor for failed innovations among learning technologists (see, for example, Anderson, Varnhagen and Campbell, 1998; Fulkerth, 2005; Geoghegan, 1995; Wilson and Stacey 2004). It should be emphasised that such 'hiccoughs' in uptake could represent delays rather than terminations: if the innovation is fundamentally worthwhile it may succeed in a subsequent generation of technology.

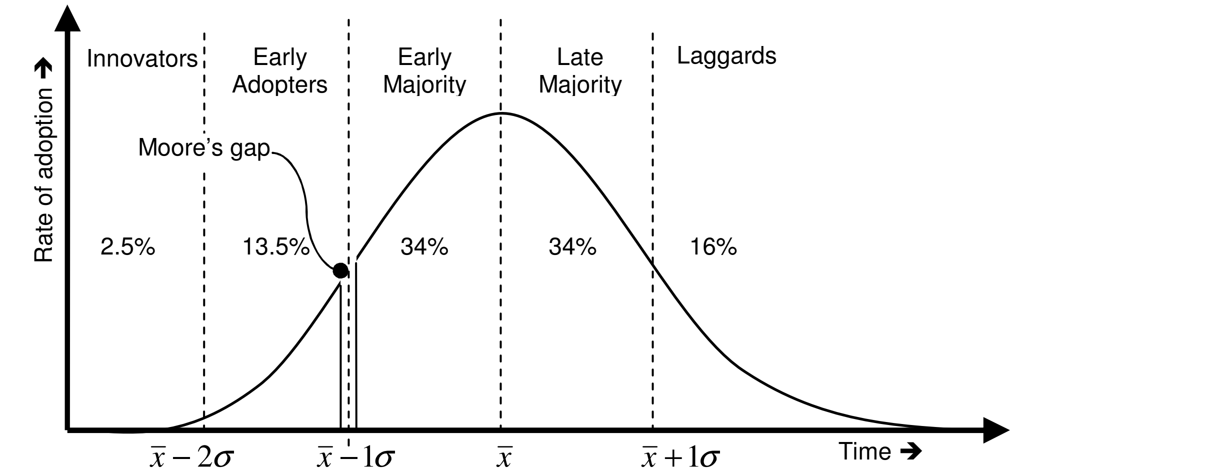


Figure 71- Moore's Gap (Moore, 1999)

Rogers recently replied that uptake is parametric and admits no such discontinuity:

> … past research shows no support for this claim of a 'chasm" between certain adopter categories. On the contrary, innovativeness, if measured properly is a continuous variable and there are no sharp breaks or discontinuities between adjacent adopter categories (although there are important differences between them). (Rogers, 2003 p. 282)

However Jacobsen (1998; 2000) showed that early adopters disguise the knowledge and skills needed to adopt e-learning innovations, which leads the mainstream majority of tutors into the fallacy that tools are easier to use than they really are. This significant finding of the research was emphasised by a learning technologist:

> … a problem with the [academic] staff is their tendency to overestimate their ability to use computers…They think maybe because they can use a wizard in POSH-CAA, that… they're an author for CAA. So - there's a real jaw-dropping stage when they… realise that they actually know very little about [CAA]… And that's with them just being exposed to authoring…. (Learning technologist LtO3M004)

Rogers' view that the features of innovations affect the rate of adoption can be summarised in five tests which map readily to research findings (Table 43). At the micro level, Evaristo and Karahanna (1998) proposed that mental workload should be added to Rogers' five features because it works as an effective brake on the uptake of technological innovations. They linked psychological literature with diffusion scholarship to show that ease of use must be considered an essential element of the decision making process and this aligns with the research findings.

Feature	Rogers' tests	Research findings
Advantage	Does the innovation indicate an advantage over current ways of doing things?	If tutors don't see real advantages in either pedagogic or productivity terms they are most unlikely to use CAA.
Compatibility	Is the innovation compatible with existing needs and expectations?	Tutors avoid using CAA if as an unnecessary complication if it is not shown inarguably to be fit for purpose.
Complexity	Does the innovation make life simpler or at least not contribute more complexity?	Ease of use emerged from the research as a critical factor in uptake. The dual path theory shows that some tutors avoid risk mitigation because it increases complexity.
Trialability	Can the innovation be tried without a commitment to completely change the current practices?	This is most evident in linear CAA trajectories where low stakes applications precede credit bearing CAA testing.
Observability	Is the innovation observable and visible to potential adopters?	Diffusion by 'word of mouth' from CAA practitioners to colleagues, departments and SMTs emerged as a critical driver.

Table 43- Mapping Rogers' features of innovations to findings

7.4.2 ORGANISATIONAL CHANGE AND CAA

The issues of why CAA uptake lags the expectations of learning technologists of how to secure its benefits are put in the context of organisational change and the shift towards centralised data systems and embedded learning technologies.

As described earlier (section 1.4), universities are being forced to adapt rapidly to changes in student profiles, the emerging market in higher education and financial pressures. This makes embedding CAA difficult because universities are a moving target:

> … every time you want to do something… somebody says 'because of [the reorganisation] … we're not quite sure how that fits in… And it's exactly an inertia of change which is a ridiculous thing to say, but because we're changing we can't do a lot of things. (Learning technologist LtO5M006)

The distinction in this research between old and new universities was made because it was useful in identifying differences in institutional practice, but limited in that some old universities appeared to exhibit features of new ones and *vice versa*. For instance one pre-1992 institution clearly had a centralised approach to CAA uptake. This is indicated figuratively below (Figure 72) showing the pattern that emerged from the research for older institutions to be both more devolved and more research-led. It shows considerable areas of overlap which indicates the compound nature of the problem.

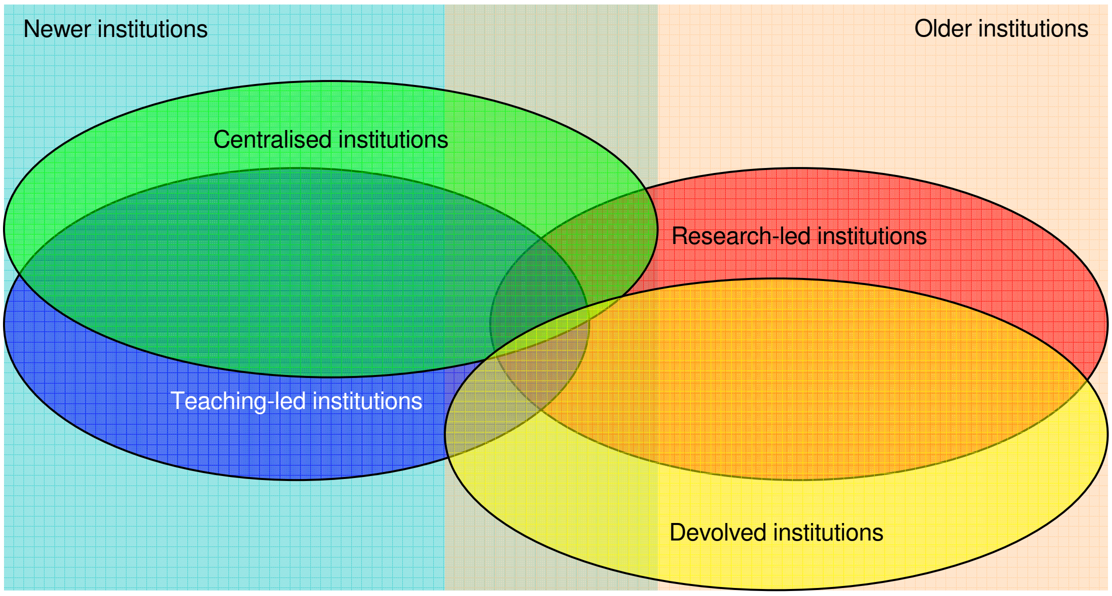


Figure 72- Entangled institution types

Attempts to provide a structured classification of universities include McNay's (1995) categorisation of four organisational types: bureaucratic, collegiate, innovative and enterprise (Figure 73).

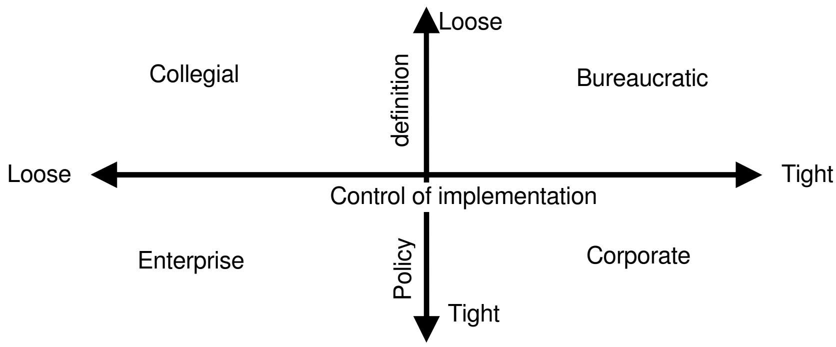


Figure 73- McNay's categorisation of organisational types (after McNay, 1995 p.106)

McNay's categorisation could be applied to distinguish better between the kinds of CAA practice that would work best with existing organisational structures. Certainly these categorisations are more subtle and are arguably more representative, of the variations found in this research. However, the same drawback, albeit to a lesser extent, applies to this approach of identifying which category a particular institution falls into. McNay saw this as a progression, but universities often have characteristics of more than one at the same time (Cornford, 2005). This entanglement should be addressed in future research on CAA uptake because it represents a loss of precision and may mask crucial differences between institutions.

Much has been written about the influence of centralised data systems on the uptake of e-learning (Danson, Hilton, Dawson, Baseley, Bullen and Easton, 2003; Dempster and Deepwell, 2002; Jefferies and Waterhouse, 2003; JISC, 2003b; Raine, 1999; Timmis, 2003; Warburton and Conole, 2005). This shift towards centralised e-learning systems appears to be driven by the recent trend towards using centrally held student data to populate VLEs and CAA systems. None of the respondents saw centralised CAA systems as an obstacle to uptake. In general, learning technologists prized them for enhanced, security, scalability, functionality and ease of support while tutors cited integration with central student record systems and general availability: 'We are using [SYSTEM-B], it is not as good as some, but is freely available without having to grovel' (Tutor AmN4F002).

The research showed agreement between tutors and learning technologists that the best test of whether CAA had been adopted by institutions was if it had become embedded in pedagogic practice. This was identified as the point where CAA became 'transparent' or taken for granted. However the research indicated that efforts to embed CAA were contentious because many tutors equated it with coercion and 'dumbing down'. The CAA community also appeared to lack a common understanding of exactly what 'embedding' should mean in terms of strategic, infrastructural and individual practice. Bacsich's alignment of embedded practice as the penultimate stage in the diffusion process may suffice (2005b pp. 20-21).

One way in which learning technologies such as CAA can become embedded is to include them in the institutional learning and teaching strategy (Beetham, 2005; Bull and McKenna, 2004). A HEFCE-commissioned survey of learning and teaching strategies in UK universities found considerable variation in responses to Dearing's (1997) call for strategic approaches to learning and teaching (Gibbs et al., 2000). The authors distinguish between four styles of strategy implementation: *devolved* in which departments developed their own strategies, *integrated* and *policy driven* in both of which existing institutional documents were considered sufficient and *strategic* in which a co-ordinated set of learning and teaching goals with mechanisms for achieving and monitoring them are collected into a single document. A fifth approach was to do nothing (2000 pp. 359-360). Less than 10% of the institutions surveyed had full plans for implementation, monitoring, or evaluation of their strategies (2000 p. 363). The authors conclude that

> 'It is unrealistic to expect that all of the components of an institutional strategy can be implemented within a relatively short time-span… Others… have knock-on effects which need to be anticipated… Developing a learning and teaching strategy for a whole institution is a complex matter… systems thinking is crucial' (2000 p. 369).

The use of toolkits which aid decision making and are derived from specific theories to facilitate embedding learning technologies such as CAA has been described by Oliver and Conole among others (Conole, Crew, Oliver and Harvey, 2001; Conole and Oliver, 2002; Oliver and Conole, 2000; Oliver, MacBean, Conole and Harvey, 2002). Toolkits can provide 'scaffolding' that bridges the gap between pedagogic theory and practice and it may be that a toolkit-based approach to embedding CAA could prove productive. However, no CAA-specific toolkit is known to exist which presents an avenue for future research.

This research has focussed on the role of learning technologists in helping to mitigate and manage the intrinsically risky nature of CAA, but Beetham, Oliver and others have shown the potential for learning technologists to act as catalysts for organisational change (see, for example, Beetham, Jones and Gornall, 2001; Oliver, 2002). The roles and responsibilities of these 'new professionals' are not yet clearly defined and seem likely to change in the future. Oliver noted one aspect of learning technologists' practice characterised as 'being responsible but without authority, relying on goodwill, expertise and rhetoric to create opportunities (both practical and educational) and influence policy' (2002 p. 251). The key to embedding learning technologies such as CAA may lie in institutions better harnessing the expertise of their learning technologists.

7.4.3 RISK AND CAA

Risk has traditionally been perceived as a purely negative fact of life like death and taxes: something to be avoided where at all possible. However, a broader understanding of the concept of risk was developed within the context of risk management in project environments at the end of the 20th century. Beck pointed out that many of the risks taken on in modern society are in fact 'manufactured' and are therefore susceptible to being 'engineered' in a similar way that they were created in the first place:

> 'The suspicion is that 'objective constraints', 'latent side effects', which stand for the 'auto-dynamism' of the techno-scientific development, are themselves manufactured and thus are in principle solvable.' (Beck, 1992 p. 157).

Bernstein's definition of risk as 'a choice rather than a fate' (Bernstein, 1996 p. 8) emphasises that risks are manageable. 'Risk' indicates a change from a known to an unknown state creating uncertainty. The aim of risk mitigation is to reduce the degree of uncertainty.

The research showed that tutors' perceptions of risk were almost exclusively negative, the only exception being a risk specialist who saw risk as something to be managed and who successfully mitigated his own risks despite being a CAA novice at the time (Harwood, 2005a; Harwood and Warburton, 2004). Naïve attitudes to risk emerged as a pivotal element in the dual path theory of uptake where a significant role for learning technologists is in managing CAA risks on tutors' behalves (see, for example, sections 4.7.2 and 6.4.2).

The idea of managing the implicit uncertainty of risk is associated with the notion of risk as a positive opportunity. The Project Management Institute (PMI) points out that '…in the project context, however, risk identification is also concerned with opportunities (positive outcomes) as well as threats (negative outcomes)" (PMI, 1996 p. 111). CAA applications can be seen as projects within the strict meaning of project risk management literature. The Project Risk Analysis and Management (PRAM) process, developed by the Association for Project Management UK risk special interest group is one widely cited prescription for identifying and managing risk within projects (Figure 74 adapted from APM, 1997 p.15).

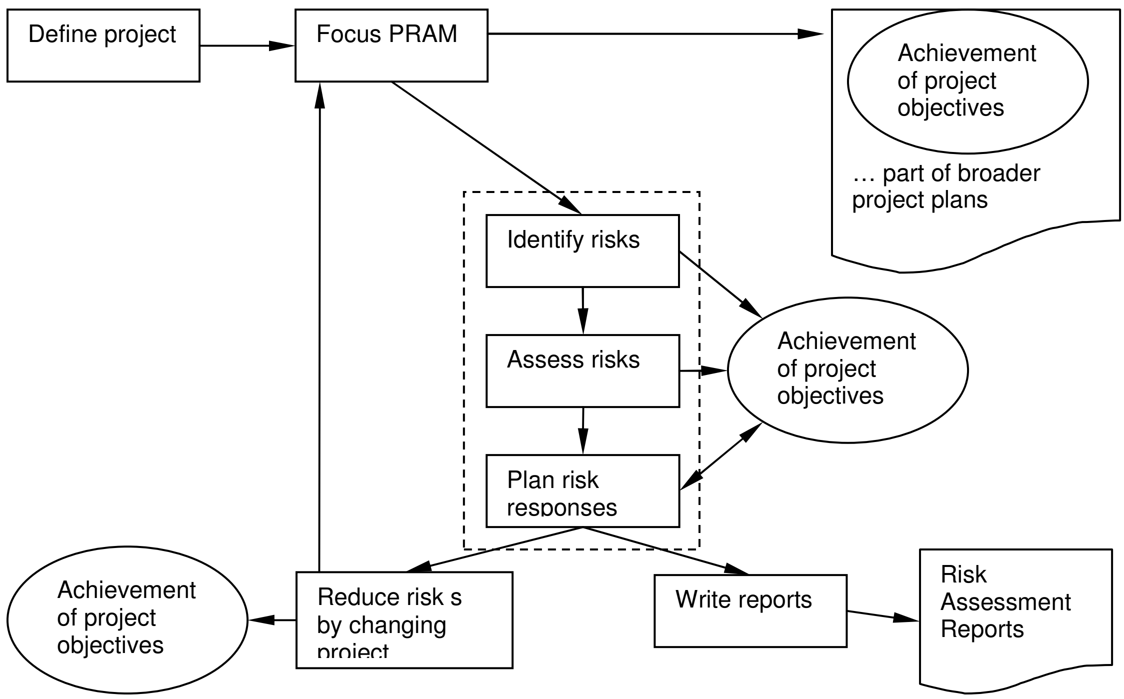
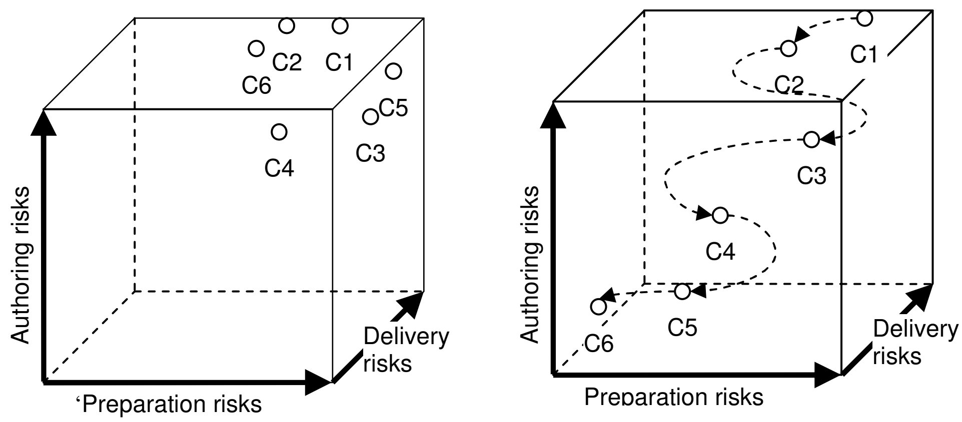


Figure 74- PRM process according to APM

Zakrzewski and Steven's (2000; 2003) CAA risk assessments document one widely understood aspect of project risk management, namely the central 'Identify-Assess-Plan' sequence shown in the dotted box of the PRM process. It is argued here that concentrating on this linear chain of consequences diverts attention from the essentially recursive nature of risk management. With Harwood I recently described how PRM techniques could be used to manage risk during the development of CAA applications (Harwood and Warburton, 2004). We advocate an iterative risk analysis approach that applies the lessons learnt from each CAA event immediately to the next CAA application rather than waiting for annual 'round ups' (2004 p. 111). We point out that CAA uptake is conditional on tutors being convinced that the new risk:return relationship is personally acceptable.

The risks of CAA applications can be divided into those associated with the authoring process such as undetected transcription errors, flaws in the publication process such as omitting to set the ‘save answers’ option and issues during delivery such as the CAA server not accepting a student’s answers at submit time. If left unaddressed these risks will not be much lessened by the time the next CAA test is due with the result that successive CAA applications could suffer unnecessarily high levels of risk with no discernable benefit (Figure 75).



Representation of risk exposure in Harwood & Warburton case study

Potential risk exposure using project risk management

Figure 75- Potential risk reduction using PRM (Harwood and Warburton, 2004)

Harnessing PRM means applying lessons learned from individual CAA instances on the micro level recursively to the CAA project at the macro level so that the risk sustained in each case is successively reduced.   The theory of dual path uptake would work well with a PRM-based approach to mitigating risk in CAA applications. This may be internal mitigation undertaken by tutors or external mitigation by learning technologists, but the essential point is to adopt a recursive approach to risk management. This could easily be included in CAA policies and procedures, but requires the active cooperation of CAA using tutors to gather the required data after each CAA instance. In this way CAA risk schedules can evolve from static ‘once for all’ documents to dynamic accounts of the current risk landscape (Chapman and Ward, 2003; Harwood and Warburton, 2004), thus facilitating risk efficient CAA practice (Figure 76).

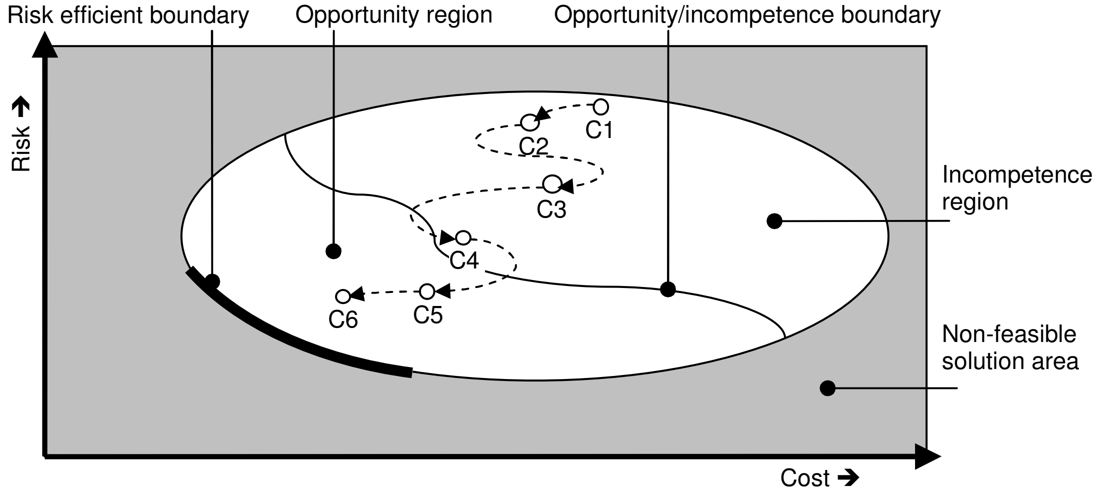


Figure 76- Risk efficient boundary (adapted from Chapman and Ward, 2003 p. 49)

This section described the research findings in context with literatures of change, specifically those of diffusion, organisational change, and project risk management . The next section reflects on the grounded theory methodology used in this research.

7.5 Reflective evaluation of methodology

Citation frequency was used in this study as a crude measure of concepts importance. An alternate measure of importance is the well-observed tendency for subjects to avoid discussing things they find difficult: such topics often emerge as crucially important issues in therapeutic interviews (see for example Robbins, 2003). I recognised that since I lacked formal therapeutic skills it would be unwise to pursue difficult topics too far. However some difficult topics- high stakes CAA failures is one example- did emerge as critical factors during axial coding with the paradigm model.

The use of memos emerged as an essential part of the process. With these some parts of the analysis almost wrote themselves and they helped immeasurably in the recall of important perceptions reached during reading and rereading of the transcripts and questionnaire responses during the cycles of 'constant comparison'. Strauss and Corbin's (1998a) prescription was indeed followed closely, although doing so was rather onerous as testified by the volume of coding shown in chapter 4. The only element of the Strauss and Corbin toolkit which was not documented formally here is their conditional/consequential matrix (1998a p.184) because it was similar to the concentric shell model (Figure 54).

7.5.1 THREATS TO THE VALIDITY OF GROUNDED THEORIES

At this point that It should be noted that, like most grounded theories, the theory of dual-path uptake developed in this thesis is *substantive*, meaning 'something that exists in its own right' (OED, 2004; Wikipedia, 2005b). In other words validity is claimed to lie principally in its explanation of phenomena associated with CAA uptake in UK universities surveyed during the research. Any scope to explain or predict CAA uptake elsewhere is strictly a matter for conjecture.

Strauss and Corbin cite eight criteria for the validity of grounded theories which if unmet are said to constitute threats to their internal or external validity.

Criteria 1, 2 and 3 are whether concepts have been generated, are numerous and are systematically related to each other (1998a pp. 270-1). It is argued that the central phenomenon of dual path uptake and core categories such as tutors' risk mitigating and risk discounting behaviour constitute good examples of such concepts. This research shows detailed examples of dense concept building in open coding (chapter 4 for example) and links core categories using axial coding tools such as mini-frameworks and the paradigm. The internal validity of the research has been maintained in these ways.

Criteria 4 and 5 are whether variation has been built into the theory and whether the conditions under which variation can be found are built into the study and explained (1998a p. 271). Explanations of phenomena include the context in which they vary (in fact this is enforced by the paradigm) and this permeates the research. For example, the organisational influence of top-down policy making has been woven into the theory of dual path uptake and the models derived from it. A case study approach would probably have been less onerous but was avoided because it might have limited the external validity of the theory. Instead a national A relevant aspect of therapeutic interviews is the well-observed tendency for subjects to avoid discussing things they find difficult: such topics often emerge as crucially important issues (see for example Robbins, 2003). I recognised that since I lacked formal therapeutic skills it would be unwise to pursue difficult topics too far. However some difficult topics- high stakes CAA failures is one example- did emerge as critical factors during axial coding with the paradigm model.survey was conducted which included in-depth interviews with different kinds of stakeholder and some care was taken to ensure that the research could be generalised in different kinds of institution.

Criterion 6 is whether process has been taken into account (1998a pp. 271-2). The dynamic nature of CAA uptake is central to this study and the internal validity of the theory has been protected from threats of this kind by asking 'what if?' questions at every stage of the research.

Criteria 7 and 8 are whether the theoretical findings seem significant and whether they stand the test of time (1998a p. 272). These constitute both internal and external threats to validity and the issues they raise are complex. The significance of the theoretical findings is perhaps a matter for the examiners of this thesis, but the fact that some of the interim outputs of the research have been judged worthy of publication by peer review may lend a degree of credibility to the findings. Whether the dual path theory will inform e-learning research in the future is a matter for posterity.

7.5.2 USE OF CAQDAS TOOLS

It was felt that neither of the CAQDAS tools used (QSR N6 and QSR Nvivo) leant themselves naturally to two essential techniques used in GT studies, namely the creation of multiple links between concepts and the constant comparison of concepts and data. This lack of flexibility caused difficulties which were partially overcome by learning in some depth how to use and then apply the in-built analytical tools. This turned out to be an onerous task in itself that at times almost defeated me. On the other hand it was almost enjoyable to be able to query the data and produce reports of exactly how many respondents in a given category had, for example, delivered invigilated tests. The impression remained that analyses of that nature could have been more easily done with a standard database program, because much of the power of these CAQDAS tools seems to lie in their ability to conduct sophisticated searches within and among documents.

7.6 Contributions made by the research

According to Philips and Pugh (1994, pp.61-62) a PhD thesis can exhibit originality in 15 different ways including

- Setting down a major piece of new information in writing for the first time
- Making a synthesis that hasn't been made before
- Taking a particular technique and applying it to a particular area
- Adding to knowledge in a way that hasn't previously been done before

It is argued here that this thesis fulfils these four criteria fully (and may satisfy some of the others partially). The principle contributions made by this research are summarised briefly according to whether they are theoretical or methodological in nature.

7.6.1 THEORETICAL CONTRIBUTION: THEORY OF DUAL PATH UPTAKE

The dual path theory is the first serious attempt to understand the mechanisms underlying the uptake of CAA and thereby build a theory with descriptive, explanatory and predictive power. Three models were derived in conjunction with it, each describing different facets of CAA uptake. The concentric shell model shows the detailed interaction of critical factors at an instant (Figure 54). The concentric cylinder model is the concentric shell model with an added time dimension and illustrates the impact of critical factors through time (Figure 65, 69). The trajectory model illustrates the effects of different tutor motivations and behaviours on uptake in the macro world (Figure 57).

Beetham describes a model as ‘a representation with a purpose’ and distinguishes between five different kinds: practice, theoretical, technical, ‘models for organisational change’ and students’ models. The dual path theory of CAA uptake developed in this research maps most closely to a highly abstracted case of Beetham’s theoretical model which is ‘intended to structure a research programme’ and which itself has already been ‘validated by research’ (Beetham, 2005 p. 2). The concentric shell, concentric cylinder and trajectory models are less abstracted cases of Beetham’s theoretical model in that they populate the conceptual dual path framework with critical factors that emerged from the research. They represent applications of the underlying dual path theory which are meant to describe and explain the way CAA uptake works in universities, but could also inform and stimulate further research (Figure 77). Theories are usually underpinned by theoretical positions - what Beetham calls a ‘theoretical paradigm’ (2005 p. 3). It may be recalled that the underlying theoretical perspective adopted in this research was a version of Interpretism that was informed by Popper’s approach to theory building (section 3.2.5).

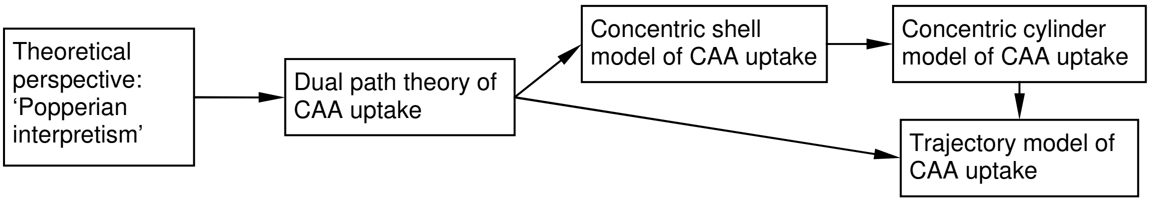


Figure 77- Theoretical perspective, dual path uptake and derivation of models

The dual path theory and its three derivative models are unknown in the literature and are offered as an original contribution to the scholarship of CAA.

7.6.2 THEORETICAL CONTRIBUTION: HIGH STAKES CAA FAILURES

The far-reaching consequences of CAA failures are not well known in the literature and the under-reporting of CAA failures emerged as a significant feature which could act either as a driver or as an obstacle to uptake (see section 7.7.4). This is offered as a contribution to the scholarship of CAA.

7.6.3 THEORETICAL CONTRIBUTION: PRM AND CAA

The original suggestion of applying project risk management (PRM) techniques to CAA applications was made by Harwood with whom I collaborated to develop the scheme for moving CAA applications successively closer to the risk efficient boundary (Figure 76) which was published jointly (Harwood and Warburton, 2004). This approach of dynamic risk mitigation is offered by us jointly as an original contribution to the scholarship of CAA.

7.6.4 THEORETICAL CONTRIBUTION: BIPOLAR AND AMPHOTERIC FACTORS

Obstacles and drivers which applied to the absence or presence of the same thing were conflated into single continuous factors with a bipolar range. The emergence of bipolar factors simplified the model of CAA uptake and accelerated theory building which culminated in the discovery of dual path uptake. They also added explanatory power to the derived models of CAA uptake and paved the way for the discovery of amphoteric factors.

The exposure of bipolar factors led to the discovery of amphoteric factors which are distinguished by their ability to change polarity from obstacle to driver or vice versa depending on conditions. This is significant because it facilitates more sophisticated accounts of the way complex structures such as universities behave under different conditions. For example, the effect of increased uptake is normally to further increase uptake and word of mouth diffusion has always been interpreted as an unambiguous driver for the uptake of any innovation (Moore, 1999; Rogers, 2003; Tarde, 1962). However, under the conditions that a CAA system has a scalability problem then the swift increases in uptake often reported in the literature (see, for example, Cosemans et al., 2002; Danson et al., 2001; Pain and LeHeron, 2003) can precipitate a disaster that has long term consequences for future uptake (Harwood, 2005a; Harwood and Warburton, 2004; Warburton and Harwood, 2004). This counter-intuitive 'Jekyll and Hyde' behaviour is offered as an original contribution to the scholarship of e-learning.

7.6.5 METHODOLOGICAL CONTRIBUTION: APPLICATION OF GT TO CAA

This is the first known application of GT to a large scale study of CAA. It combines interview transcripts and free text collected from questionnaires as basic data (Warburton, 2005) which is legitimate (Glaser and Strauss, 1967 pp. 162-163; Strauss and Corbin, 1998a p. 29) but unseen in the literature. This research includes a detailed account of the internal workings of a substantial GT study conducted faithfully according to Strauss and Corbin's (1998a) prescription and is offered as a template for other GT studies in the social sciences.

7.7 Suggestions for extending the research

The shift towards online testing appears from this research to have accelerated. However, uptake continues to lag behind enthusiasts' expectations and it seems probable that current (and foreseeable) generations of CAA tools will continue to require specialist skills. At the level of individual tutors, known difficulties in question-writing seem likely to require authors to become experts in the construction of good items: how will they find the time? At the infrastructural level the implementation of risk mitigation measures appears to be an under-researched field. At the strategic level little seems to be known about the way different organisational structures affect CAA uptake. All of these are fertile grounds for further research. Some stakeholders were not included or were under-represented in this research. For example, the views of QA staff and senior managers appear to be crucial to uptake, whilst students emerged as key arbiters of ‘success’ in CAA applications and non-adopters of CAA represent future uptake. Extensions of this work could include any of these.

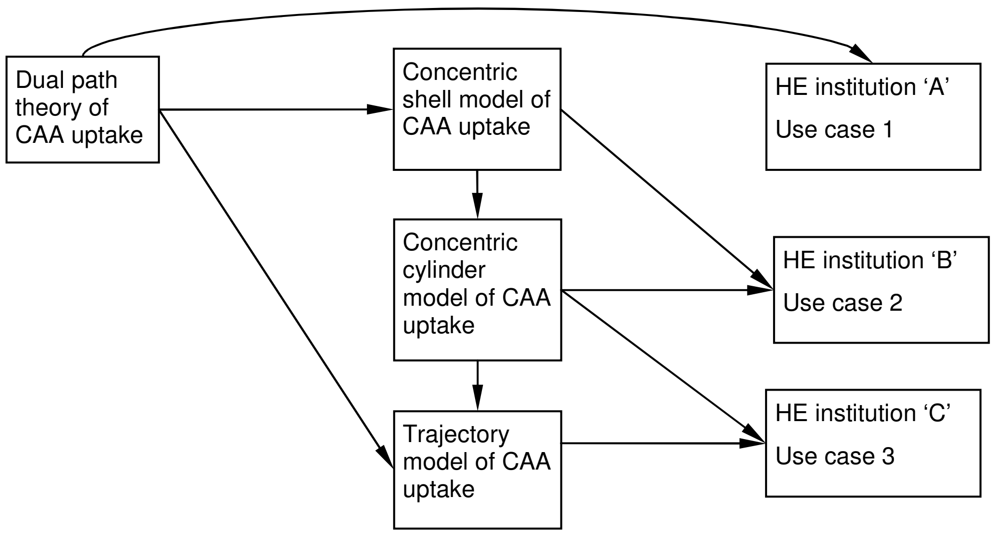


Figure 78- Applications of dual path uptake and derived models

Applications of the substantive dual path theory might include stimulating and informing further research in CAA uptake, such as the way different universities approach risk mitigation and the impact this has on uptake (Figure 78, use case 1). The three models derived from the dual path theory could be used as tools for understanding existing CAA practice, such as informing an investigation into unexpectedly low uptake in a particular department (Figure 78, use case 2) or to predict the effects of making changes to existing practice such as enshrining CAA policies and procedures into an institutional learning and teaching strategy document (Figure 78, use case 3).

The CAA community appears to lack a CAA-specific toolkit of the kind that has been proposed for other learning technologies. It may be possible to develop one which could be used to facilitate embedding CAA by assisting with the decision-making process and it is felt that this represents another possible avenue for future research.

7.8 Conclusions

This research has advanced the understanding of how CAA is taken up in UK universities. The initial literature review provided a comprehensive and useful description of the CAA landscape which was drawn on as the basis for several peer reviewed accounts (Conole and Warburton, 2005; Warburton and Conole, 2003a; Warburton and Conole, 2005). The interim findings of the 2003 survey were published in the proceeding of a peer reviewed conference (Warburton and Conole, 2003b) and two papers were published in the proceeding of peer reviewed international conferences on the application of PRM to CAA (Harwood and Warburton, 2004; Warburton and Harwood, 2004).

The dual path theory of uptake may have predictive power and the models derived from it satisfied some well qualified and experienced critics as good explanations of the way they had seen CAA taken up in UK universities (section 6.2.1). Some of the findings were quite unexpected, particularly the operation of amphoteric factors and the phenomenon of risk discounting behaviour. However, the opinions of students were not directly included in the surveys, the data from which came largely from tutors and support staff who were early adopters and innovators. It is recognised that this may have distorted the theory, and should be considered when generalising from the findings. Moreover, because survey respondents were in general working only with the cognitive domain of Bloom's taxonomy, other areas such as the use of CAA in the assessment of psycho-motor skills are excluded.

Finally, this research has shown that Bull's call for cultural factors to be the focus of efforts to understand CAA uptake remains valid: 'The organisational and pedagogical issues and challenges surrounding the take-up of CAA often outweigh the technical limitations of software and hardware.' (Bull, 2001 p. 11)

Appendix A: Analysis & results of phase 1 survey

Responses to Phase 1 scoping survey

One response was received from each of five UK universities. The average scores given by respondents are listed below (Table 44) and a detailed breakdown is given in Appendix A. It should be born in mind that the scores are an average of respondents' reactions on a scale of 0 to 4 where 0 is represents no activity and 4 represents a fully mature status.

Phase 1 scoping survey questions		**Mean**
Culture: does the institution commit real resources to CAA?		
1	Institutional profile of CAA	2.3
2	Profile of CAA support services	2.4
3	Recognition and reward of innovation in CAA	1.4
4	CAA R&D	2.2
Infrastructure: to what extent has the institution integrated CAA into its practice?		
5	CAA infrastructure	2.4
6	CAA support	2.6
7	CAA funding	1.6
8	Administrative infrastructure	2.1
Expertise: What CAA skills and experience do staff and students have?		
9	Staff use of CAA	2.8
10	Student use of CAA	1.0
11	Networks & collaboration	2.8

Table 44- Phase 1 scoping survey questions

CULTURE

CAA was perceived as being important to institutions (Table 45).

Q.1 Institutional profile of CAA	**Mean**
a) There is a strong institutional commitment to CAA	2.4
b) The most senior member of the CAA team is part of senior management	1.8
c) The CAA committee (or equivalent) has significant (independent control over) budgets	1.2
d) CAA processes are well established centrally and locally	1.4
e) There is (at least one) institution-wide initiative to promote CAA excellence and innovation	2.4
f) Academics have been effectively involved in the development and implementation of the CAA strategy	3.0
g) CAA staff contribute to the (disciplinary) scholarship of teaching	3.0

Table 45- Phase 1 scoping: Institutional profile of CAA

The responses received indicated that academics were perceived to be at the beginning of getting to grips with CAA (1e,f). In all but one of the institutions, CAA administrators and learning technologists were perceived as making some contribution to L&T scholarship (1g). However, the perceived institutional profile of CAA varied widely amongst institutions (1a) and CAA steering groups were seen by these learning technologists as having little budgetary control (1b,c). Generally, CAA processes were not yet assessed as well established (1d).

CAA support services were generally seen as pervasive, but not necessarily as a driver for uptake (Table 46).

Q.2 Profile of support services	Mean
a) Teaching staff have access to a CAA system they can use with students	3.4
b) Departments make a concerted effort to integrate CAA into their programmes	1.8
c) Use of CAA is incorporated into curriculum planning (e.g. module documentation)	2.4
d) Use of CAA is leading to changes in teaching styles and culture	1.6
e) CAA is a key driver of institutional mission (e.g. towards a virtual campus)	1
f) There is (at least one) central unit/service to support staff use of CAA	3.6
g) There is (at least one) institution-wide initiative to promote good practice and innovation in CAA	3.4
h) L&T strategy includes clear aims, targets and resource plans with respect to CAA	2.2
i) Dept/service teams develop their own local plans to meet strategic CAA aims	1.6

Table 46- Phase 1 scoping: Profile of support services

Almost all academics have access to a live CAA system of some kind and most had the benefit of a central CAA support service (2a). Most institutions have a central initiative to promote good CAA practise (2g). However, CAA is not perceived as an institutional driver for L&T nor does it seem to be embedded within the culture (2c,d,e,h). Departments were not seen to develop their own local plans for implementing CAA (2b,i).

A mixed picture emerged of recognition and reward in CAA (Table 47).

Q.3 Recognition and reward	Mean
a) Role of CAA innovator is recognised through secondments or specific roles (*for which time is allocated/bought out*)	1.6
b) There are specific professional rewards for CAA innovation (e.g. additional funding, progression points, teaching fellowships)	1.2
c) New CAA ideas and projects are supported through an institutional innovations fund (or similar)	2.0
d) CAA innovators have opportunities to publicise their work to colleagues, through e.g. a web site, newsletter or seminar programme	2.0
e) CAA innovators occupy senior academic positions	1.0
f) Non-academic staff working in CAA have access to outcomes-related rewards	0.8

Table 47- Phase 1 scoping: Recognition and reward

In over half the institutions no time was allowed or bought out for CAA development (3a). If material rewards are a measure of institutional commitment, then innovation in CAA is not highly regarded by institutions (3a,b). iess appear to vary in the degree to which they support CAA endeavour (3c,d) in academic terms and in general were not perceived to materially reward academic and non-academic staff for CAA development (3e,f).

CAA research and development (Table 48) was seen to be largely centralised in specialist departments (4a).

Q.4 CAA R&D	Mean
a) There is a specialist department or unit concerned with CAA research and development	2.8
b) There is support for staff in departments who are undertaking development projects or action research in CAA	2.6
c) Unit(s) concerned with CAA development has/have close links with the dept/ faculty of education	1.4
d) CAA specialist publications have been/will be included in the education RAE	1.0
e) The institution attracts external funding (e.g. TLTP) for CAA research and development	3.0
f) The institution is a nationally recognised centre of excellence for CAA research and development	2.4

Table 48- Phase 1 scoping: CAA R&D

In all cases but one, there was seen to be at least some CAA support for academics that were embarking on CAA projects (4b). Almost all participating institutions attracted external funding for CAA R&D and in some cases had emerged as centres of excellence for CAA R&D (4e,f). However, CAA developers did not necessarily collaborate with education departments and CAA seldom appeared in education departmental RAE returns (4c,d).

INFRASTRUCTURE

CAA infrastructure (Table 49) was seen still to be developing.

Q.5 CAA infrastructure	**Mean**
a) There is a dedicated workstation area suitable for **formative** CAA testing	1.8
b) There is a dedicated workstation area suitable for **summative** CAA testing	1.2
c) CAA is universally available and supported	3.4
d) There is an managed learning environment (MLE/VLE) which can be accessed by staff and students, on and off campus	3.4

Table 49- Phase 1 scoping: CAA infrastructure

CAA is usually available institution-wide (5c). Virtual learning environments such as Blackboard or WebCT are pervasive (5d). However, there was little recognition of dedicated provision for formative testing and still less for summative CAAs conducted under exam conditions[4] (5a,b).

CAA support (Table 50) was generally seen to be centralised, but untargeted.

Q.6 CAA support	**Mean**
a) CAA applications are supported alongside other software and systems by computer services (or equivalent)	3.0
b) There is targeted support for teaching staff looking to integrate CAA into their courses	2.8
c) There is targeted support for the development of new CAA applications and materials	1.8
d) CAA support is available both centrally and locally on demand	2.6
e) CAA support staff have ongoing appraisal, development opportunities and career progression	3.4

Table 50- Phase 1 scoping: CAA Support

CAA applications tend to be centrally supported by the institution's IT department (6a,d). Academics embarking on funded CAA projects benefit from targeted support which is presumably funded by such projects (4b,6b). It was recognised CAA support staff were 'invested in' (6e), although it seemed there was little targeted support for developing new CAA applications and materials (5c).

CAA Funding (Table 51) was secure, but not well targeted where most needed.

[4] These are also the kinds of high stakes assessments which are the subject of British Standard 7988 (BS7988) and which on anecdotal evidence gave the greatest concern to CAA specialists.

Q.7 CAA funding	Mean
a) There is (at least one) institution-wide initiative to fund CAA development projects	1.6
b) CAA support unit(s) or service(s) have secure central funding	3.0
c) Investment in infrastructure is used to leverage change in CAA practices	0.4
d) Funding is strategically targeted to reflect current CAA priorities	1.0
e) External CAA funding opportunities are strategically exploited	2.0

Table 51: Phase 1 scoping: CAA Funding

In most cases, CAA services have some sort of secure institutional funding (7b). *However*, universities are polarised regarding institution-wide CAA initiatives (7a). Investment in infrastructure was seldom viewed as leading to better CAA (7c). CAA priorities did not necessarily go in hand-in-hand with funding (7d, e).

A mixed picture was painted of administrative infrastructure (Table 52).

Q.8 Administrative infrastructure	Mean
a) All L&T programmes are subject to common standards and internal QA processes (e.g. course validation and review)	3.8
b) Standards and QA processes have been adapted to take into account programmes delivered wholly or partly through use of LT	1.6
c) Standards and QA processes are reviewed regularly to ensure they do not present obstacles to innovation	2.4
d) Computerised administrative and MIS systems allow staff to access student data easily	1.6
e) Computerised student management systems are fully integrated with learning applications	1.4
f) System outputs are used for institutional research and curriculum planning	1.2

Table 52: Phase 1 scoping: Administrative infrastructure

All L&T programmes are subject to common standards and internal QA processes (8a). However, the surveyed institutions were split regarding the integration of Student Management Systems with CAA and VLEs (8b,e). CAA and VLEs QA processes have some way to go before they are formally integrated with traditional exam procedures (8c,d,e). universities made little use of CAA for curriculum planning or for research at an institutional level.

EXPERTISE

Staff use of CAA (Table 53) was widespread in the surveyed institutions.

Q.9 Staff CAA skills	Mean
a) All teaching staff have training in the construction of objective questions	0.6
b) All teaching staff have access to a CAA system suitable for **formative** testing	3.4
c) All teaching staff have access to a CAA system suitable for **summative** testing	2.8
d) There are regular staff/educational development activities which address pedagogical skills/learning contexts of CAA as well as technical skills	3.0
e) Staff development is integrated into the roll-out of all new CAA applications	2.0
f) There is a cohort of experienced CAA users across the institution	3.0
g) There is a coordinated approach to staff CAA skills (e.g. involving staff development, computer services and education/learning development)	2.8
h) There is (at least one) specialist professional development programme in embedding CAA into the curriculum	2.4

Table 53: Phase 1 scoping: Staff CAA skills

In all participating institutions, academics were reported as having access to a CAA system suitable for formative testing, but unsurprisingly this was less true for summative testing which is inherently more demanding (9b,c). It was widely believed that staff development should be factored in to CAA roll-outs (9d,e). Learning technologists believed that a cohort of experienced CAA users had been established within their institutions (9f). The respondents were polarised in their assessment of CAA professional development program provision (9g,h) and in only one case were all teaching staff perceived as having appropriate training in the construction of objective questions (9a).

Routine student use of CAA (Table 54) lagged expectations in the surveyed institutions.

Q.10 Student use of CAA	**Mean**
a) All students are routinely exposed to **formative** CAA testing	1.0
b) All students are routinely exposed to **summative** CAA testing	1.0

Table 54: Phase 1 scoping: Student use of CAA

Although this could be seen as an acid test of whether CAA is actually 'earning its keep', it lags the other surveyed factors significantly and received the lowest score. It appears that most of the surveyed institutions are taking a cautious approach; they are still preparing the ground rather than 'getting their hands dirty' with CAA on a large scale.

Networks and collaboration (Table 55) were still maturing in the surveyed institutions.

Q.11 Networks & collaboration	**Mean**
a) Information on current CAA developments is collected and disseminated by a central unit	3.2
b) There are opportunities for staff to share ideas and experiences in CAA (e.g. lunchtime workshops, email discussion forum)	2.4
c) Units, teams and individuals with a CAA role are centrally coordinated and share information effectively	2.8
d) There are established internal networks to disseminate CAA-related information (e.g. via department reps/coordinators)	2.6
e) Institution shares CAA expertise with other institutions/organisations (e.g. via collaborative networks, projects)	3.6
f) Institution leads or is active in (at least one) national/international initiative in CAA (e.g. TOIA, CAA Centre)	4
g) Institution receives national Funding Council funding (e.g. via TLTP, JISC) for a collaborative CAA development project	4
h) CAA use is a major feature of the institution's external profile (e.g. in marketing to potential students	0.8
i) There is strategic exploitation of external CAA funding, commercial opportunities and national drivers	2.2

Table 55: Phase 1 scoping: Networks & collaboration

As might be expected, all the participating institutions attracted national funding for innovation in CAA and it is at least largely true that the surveyed institutions share CAA expertise with other institutions (11e,f,g). Most of the institutions have central CAA functions that collect and disseminate information on developments in CAA (11a,c,d). The institutions seem to be at every possible stage of exploiting external CAA funding (11i). But CAA use did not yet appear to be a major factor in participating institutions' marketing to potential students (11h).

Full data from Phase 1 scoping survey

1. Institutional profile of CAA	Untrue (0)	Emergent (1)	Partly true (2)	Largely true (3)	True (4)	Mean
a) There is a strong institutional commitment to CAA	0	1	2	1	1	2.4
b) The most senior member of the CAA team is part of senior management	2	0	1	1	1	1.8
c) The CAA committee (or equivalent) has significant (independent control over) budgets	2	1	1	1	0	1.2
d) CAA processes are well established centrally and locally	1	3	0	0	1	1.4
e) There is (at least one) institution-wide initiative to promote CAA excellence and innovation	1	0	2	0	2	2.4
f) Academics have been effectively involved in the development and implementation of the CAA strategy	1	1	0	2	2	3
g) CAA staff contribute to the (disciplinary) scholarship of teaching	1	0	1	1	2	3

Table 56- Institutional profile of CAA

2. Profile of support services	Untrue (0)	Emergent (1)	Partly true (2)	Largely true (3)	True (4)	Mean
a) Teaching staff have access to a CAA system they can use with students	0	0	0	1	4	3.4
b) Departments make a concerted effort to integrate CAA into their programmes	1	1	2	0	1	1.8
c) Use of CAA is incorporated into curriculum planning (e.g. module documentation)	1	0	2	0	2	2.4
d) Use of CAA is leading to changes in teaching styles and culture	0	2	1	0	1	1.6
e) CAA is a key driver of institutional mission (e.g. towards a virtual campus)	3	1	0	0	1	1
f) There is (at least one) central unit/service to support staff use of CAA	0	0	1	0	4	3.6
g) There is (at least one) institution-wide initiative to promote good practice and innovation in CAA	0	0	1	1	3	3.4
h) L&T strategy includes clear aims, targets and resource plans with respect to CAA	1	1	1	0	2	2.2
i) Dept/service teams develop their own local plans to meet strategic CAA aims	2	0	1	2	0	1.6

Table 57- Profile of support services

3. Recognition and reward	Untrue (0)	Emergent (1)	Partly true (2)	Largely true (3)	True (4)	Mean
a) Role of CAA innovator is recognised through secondments or specific roles (for which time is allocated/bought out)	3	0	0	0	2	1.6
b) There are specific professional rewards for CAA innovation (e.g. additional funding, progression points, teaching fellowships)	2	2	0	0	1	1.2
c) New CAA ideas and projects are supported through an institutional innovations fund (or similar)	2	0	1	0	2	2.0
d) CAA innovators have opportunities to publicise their work to colleagues, through e.g. a web site, newsletter or seminar programme	2	0	1	0	2	2.0
e) CAA innovators occupy senior academic positions	3	0	1	1	0	1.0
f) Non-academic staff working in CAA have access to outcomes-related rewards	3	1	0	1	0	0.8

Table 58- Recognition and reward

4. CAA R&D	Untrue (0)	Emergent (1)	Partly true (2)	Largely true (3)	True (4)	Mean
a) There is a specialist department or unit concerned with CAA research and development	0	0	2	0	3	2.8
b) There is support for staff in departments who are undertaking development projects or action research in CAA	1	0	1	1	2	2.6
c) Unit(s) concerned with CAA development has/have close links with the dept/ faculty of education	2	1	1	0	1	1.4
d) CAA specialist publications have been/will be included in the education RAE	3	1	0	0	1	1.0
e) The institution attracts external funding (e.g. TLTP) for CAA research and development	1	0	1	0	3	3.0
f) The institution is a nationally recognised centre of excellence for CAA research and development	2	1	0	1	2	2.4

Table 59- CAA R&D

5. CAA infrastructure	**Untrue (0)**	**Emergent (1)**	**Partly true (2)**	**Largely true (3)**	**True (4)**	**Mean**
a) There is a dedicated workstation area suitable for formative CAA testing	2	0	2	0	1	1.8
b) There is a dedicated workstation area suitable for summative CAA testing	3	0	1	0	1	1.2
c) CAA is universally available and supported	0	0	1	1	3	3.4
d) There is an managed learning environment (MLE/VLE) which can be accessed by staff and students, on and off campus	0	1	0	0	4	3.4

Table 60- CAA infrastructure

6. CAA support	**Untrue (0)**	**Emergent (1)**	**Partly true (2)**	**Largely true (3)**	**True (4)**	**Mean**
a) CAA applications are supported alongside other software and systems by computer services (or equivalent)	0	0	0	2	3	3.0
b) There is targeted support for teaching staff looking to integrate CAA into their courses	1	0	0	2	2	2.8
c) There is targeted support for the development of new CAA applications and materials	2	0	1	1	1	1.8
d) CAA support is available both centrally and locally on demand	1	0	1	1	2	2.6
e) CAA support staff have ongoing appraisal, development opportunities and career progression	0	0	1	1	3	3.4

Table 61- CAA support

7. CAA funding	**Untrue (0)**	**Emergent (1)**	**Partly true (2)**	**Largely true (3)**	**True (4)**	**Mean**
a) There is (at least one) institution-wide initiative to fund CAA development projects	3	0	0	0	2	1.6
b) CAA support unit(s) or service(s) have secure central funding	1	0	0	1	3	3.0
c) Investment in infrastructure is used to leverage change in CAA practices	3	2	0	0	0	0.4
d) Funding is strategically targeted to reflect current CAA priorities	2	2	0	0	1	1.0
e) External CAA funding opportunities are strategically exploited	1	0	3	0	1	2.0

Table 62- CAA funding

8. Administrative infrastructure	Untrue (0)	Emergent (1)	Partly true (2)	Largely true (3)	True (4)	Mean
a) All L&T programmes are subject to common standards and internal QA processes (e.g. course validation and review)	0	0	0	1	4	3.8
b) Standards and QA processes have been adapted to take into account programmes delivered wholly or partly through use of LT	1	1	2	1	0	1.6
c) Standards and QA processes are reviewed regularly to ensure they do not present obstacles to innovation	0	2	0	2	1	2.4
d) Computerised administrative and MIS systems allow staff to access student data easily	1	0	2	2	0	1.6
e) Computerised student management systems are fully integrated with learning applications	2	1	0	2	0	1.4
f) System outputs are used for institutional research and curriculum planning	1	2	2	0	0	1.2

Table 63- Administrative infrastructure

9. Staff CAA skills	Untrue (0)	Emergent (1)	Partly true (2)	Largely true (3)	True (4)	Mean
a) All teaching staff have training in the construction of objective questions	4	0	0	1	0	0.6
b) All teaching staff have access to a CAA system suitable for formative testing	0	0	0	1	4	3.4
c) All teaching staff have access to a CAA system suitable for summative testing	1	0	1	0	3	2.8
d) There are regular staff/educational development activities which address pedagogical skills/learning contexts of CAA as well as technical skills	0	0	0	2	3	3.0
e) Staff development is integrated into the roll-out of all new CAA applications	0	1	0	2	2	2.0
f) There is a cohort of experienced CAA users across the institution	0	0	2	1	2	3.0
g) There is a coordinated approach to staff CAA skills (e.g. involving staff development, computer services and education/learning development)	0	2	0	0	3	2.8
h) There is (at least one) specialist professional development programme in embedding CAA into the curriculum	1	1	0	1	2	2.4

Table 64- Staff CAA skills

10. Student use of CAA	Untrue (0)	Emergent (1)	Partly true (2)	Largely true (3)	True (4)	Mean
a) All students are routinely exposed to formative CAA testing	2	1	2	0	0	1.0
b) All students are routinely exposed to summative CAA testing	2	1	2	0	0	1.0

Table 65- Student use of CAA

11. Networks & collaboration	**Untrue (0)**	**Emergent (1)**	**Partly true (2)**	**Largely true (3)**	**True (4)**	**Mean**
a) Information on current CAA developments is collected and disseminated by a central unit	0	1	0	1	3	3.2
b) There are opportunities for staff to share ideas and experiences in CAA (e.g. lunchtime workshops, email discussion forum)	0	1	2	1	1	2.4
c) Units, teams and individuals with a CAA role are centrally coordinated and share information effectively	0	1	1	1	2	2.8
d) There are established internal networks to disseminate CAA-related information (e.g. via department reps/coordinators)	1	0	1	1	2	2.6
e) Institution shares CAA expertise with other institutions/organisations (e.g. via collaborative networks, projects)	0	0	0	2	3	3.6
f) Institution leads or is active in (at least one) national/international initiative in CAA (e.g. TOIA, CAA Centre)	0	0	0	0	5	4
g) Institution receives national Funding Council funding (e.g. via TLTP, JISC) for a collaborative CAA development project	0	0	0	0	5	4
h) CAA use is a major feature of the institution's external profile (e.g. in marketing to potential students	3	1	0	1	0	0.8
i) There is strategic exploitation of external CAA funding, commercial opportunities and national drivers	0	2	1	1	1	2.2

Table 66- Networks & collaboration

Appendix B: Phase 2 2003 questionnaire

UK CAA Survey Questionnaire 2003

Text in **red** indicates proposed additions to the 1999 academic version of the questionnaire
Text in **blue** indicates proposed deletions from the 1999 academic version of the questionnaire

Thank you for taking the time to answer this questionnaire. All responses will be kept confidential. If you have any queries about questions, please contact us on xxxxx xxxxxxx or email xxxx@xxxxxxxxx.

All completed questionnaires received by 1st **May 2003** will be entered into a draw **for xxxxxxxxxxx**

Personal and Professional Details (optional)

Please complete and amend as necessary.

Name (optional):

Address:

Telephone:

Email:

Job title:

Subject area:

Which of the following describe your position?

(Please tick all that apply.)

(a) Full-time/ part-time

(b) Academic/ pedagogic support/ ICT support

(c) Permanent/ short-term contract/ hourly paid

(d) **Sex:** male/ female

(e) **Age:** 21-30/ 31-40/ 41-50/ 51-60/ 61 +

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1. Which of the following statements most accurately describes your experience with CAA?

(a) I currently use CAA, advise on the use of CAA or support CAA

(b) I currently do not use CAA, advise on the use of CAA or support CAA

(c) I have used, advised on, or supported CAA in the past, *but no longer do so.*

2. Do you intend to use CAA in the future? Yes/ No/ Maybe

3. If you teach, are you currently using computer-aided learning (CAL) in your teaching, excluding word processing and spreadsheets? Yes/ No

4 If you have CAA support for academics at your institution

(a) Where is this located? (Please tick all that apply.) As a central unit/ Within faculties/academic departments/ Elsewhere (please specify)

(b) Does your institution have a dedicated CAA department or officer(s)? Yes/ No

5. If you teach, how likely would you be to use CAA IF …

1 = very unlikely **2** = unlikely **3** = neutral **4** = likely **5** = very likely

Please enter a number from those listed above

(a) You had to create a test AND computerise it

(b) You created a test BUT SOMEONE computerised it for you

(c) Tests were available BUT you had to computerise them

(d) Tests were available BUT SOMEONE computerised them for you

(e) Appropriate computerised tests were already available for use

6. To what extent do you agree with the following statements

1 = strongly disagree **2** = disagree **3** = not sure **4** = agree **5** = strongly agree

Please enter a number from those listed above

(a) CAA allows for in-depth statistical analysis of examination questions (eg. facility and discrimination).

(b) CAA enables the generation of a wide range of reports analysing student performance.

(c) CAA exams entail fewer security risks than paper exams.

(d) CAA is more costly than paper-based assessment methods.

(e) CAA is more time-consuming than paper-based assessment methods.

(f) It is possible to test lower order learning, such as knowledge and comprehension, using objective tests.

(g) It is possible to test higher order learning, such as critical analysis and evaluation, using objective tests.

(h) Computerised marking saves academic staff a significant amount of time.

(i) Training in CAA software and pedagogy should be available centrally within an institution.

(j) Support staff should be solely responsible for the technical and operational aspects of CAA.

(k) CAA offers greater objectivity in marking than tutor-marked assessments.

(l) Student anxiety about using computers is a significant problem with CAA.

(m) Academic staff anxiety about using computers is a significant problem with CAA.

(n) Creating good CAA questions requires much time and effort.

(o) Academic staff benefit from writing appropriate CAA questions (eg. encourages careful consideration of assessment; enhances question design skills).

(p) An important advantage of formative CAA is to allow students to work at their own pace and as frequently as necessary.

(q) CAA significantly aids learning and revision.

(r) CAA offers a wide range of question types.

(s) CAA can only be used to test some disciplines.

(t) CAA offers the potential to test a broad range of subject knowledge.

(u) CAA enables tutors to offer more feedback than is possible with paper-based methods.

(v) CAA improves the speed of feedback of results and comments to students.

(w) Objective tests result in inflated scores due to guessing.

(x) Objective testing is a good method of assessing material typically found in level one/two (eg. first and second year) modules.

(y) Objective testing is a good method of assessing material typically found in level three (eg. final year) or postgraduate modules.

(z) It is desirable to incorporate multimedia applications (film, audiotape, photographs, movable objects) into assessment.

7. (a) Please list any advantages to using CAA that you have identified:

(b) Please list any disadvantages to using CAA that you have identified:

8. What do you see as the critical success factors for the implementation of CAA?

(a) At level of the individual academic:

(b) At level of the institution:

9. What do you see as the main obstacles to the successful implementation of CAA?

(a) At level of the individual academic:

(b) At level of the institution:

10. What do you perceive to be the attitude of each of the following groups towards CAA:

1 = very negative **2** = negative **3** = neutral **4** = positive **5** = very positive

Please enter a number from those listed above

(a) Students

(b) Academic staff

(c) Senior management

(d) External examiners

(e) Technical staff

11. Would any of the following be useful in supporting your use of CAA? (For each please specify further details.)

(a) Staff development

(b) Institutional support

(c) National support

(d) Hardware provision

(e) Software provision

12. What future developments in CAA would you like to see?

~~**13. To what extent would you benefit from a national centre of CAA expertise and advice?**~~

~~Very much/ Somewhat/ Not very much/ Not at all~~

~~(a) What types of support would you like to be offered by such a centre?~~

If you CURRENTLY USE CAA, please complete the rest of the questionnaire. IF YOU DO NOT, please go to the final survey section which starts at Q.23 and which include the Survey Feedback Details section.

14. Why and when did you start using CAA?

15. Do you use question banks? Yes/ No

(a) If yes, please give details:

16. Would you be interested in sharing questions with academics at other institutions? Yes/ No

(a) If yes, please give details:

17. Have you evaluated your students' use of CAA? Yes/ No

(a) If yes, please give details:

18. Have you ever used CAA with students with special needs? Yes/ No

(a) If yes, please give details:

19. Please give details of each computer-assisted assessment which you use on the table below, using one row for EACH assessment.

(Where a choice is offered, please tick all boxes which apply.) Please photocopy as appropriate.

(a) Module title AND year level

(b) Method of delivery Closed computer network/ stand alone/ web-based/ OMR

(c) Type of assessment diagnostic/ formative/ summative/ self-assessment

(d) Question types/format MCQs/ multi-response/ text input/ numeric input/ graphical hot spots/ audio/video /other

(e) Is the assessment invigilated? Yes/ No

(f) Number of students performing assessment

(g) What other assessments are used in this module? essay – coursework/ essay – exam/ short answer questions/ lab report/ presentation/ objective test/ worksheets/ other

(h) What is the weighting (%) of the CAA within the module?

20. Do you receive support from any of the following for your use of CAA? (Please specify what form this support takes, e.g. funding, time released, staff, additional hardware/software resources.)

Department

Faculty

Institution

External

Other

21. What CAA software packages are you using? Please list all packages and indicate which delivery method they relate to (summative/formative etc.)

22. What do you see as the particular advantages and disadvantages of the CAA software you use?

23. If academic staff at your institution use CAA, is it your view that they are saving their own time? Yes/ No

If yes, has this meant a significant shift in the workloads of other staff?

If yes, please give details of who, how and number of extra hours per week.

24. Which of the following statements describe the experience of the staff at your institution with CAA? Choose one: A significant percentage (20% or more) currently uses CAA/ Only a small group of enthusiasts use CAA/ No-one uses CAA/ Some have used CAA in the past, but no longer do so/ Some may be using it, but I am not aware of their use. CHECK!!

25. Does your institution already provide an institution-wide Virtual Learning Environment (VLE) e.g. Blackboard or WebCT? Yes/ No

If Yes, do you think it has: encouraged people to use CAA/ *discouraged* people from using CAA

would you like to be able to export quizzes from your VLE to a CAA system

26. Interoperability standards:

Describe interoperability & use QTI & SCORM as examples

How important to you is the ability to 'future proof' CAA interoperability, such as the ability to transfer questions and assessments from one CAA system to another? Very important/ Moderately important/ Not really important/ Not at all important

Are you aware of CAA interoperability standards such as the IMS QTI specification? Very aware/ Moderately aware/ Not really aware/ Not at all aware

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Survey Feedback Details

Thank you very much for your time and effort.

The results of this survey will be published in a variety of formats, including electronic publications available from our website (http://xxxxxxxxxxxxxxxxxx).

If you would like to receive further information about results of the survey, other project activities and CAA developments, **please tick here** and ensure that your full contact details appear on the first page of this questionnaire.

- **If there are any aspects of CAA you are particularly interested in please detail them below:**
- **Can we contact you by telephone or email to follow up on your responses?** Yes/ No
- Suitable days and times to call:

Appendix C: Phase 2 2004 questionnaire

Full Edition of UK CAA Questionnaire (2004)

Thank you for taking the time to answer this questionnaire. All responses will be kept confidential and the raw data deleted as soon as it has been coded. If you have any queries about questions, please contact us on 023 8059 2326 or email wiw@soton.ac.uk
All completed questionnaires received by the end of June 2004 will be entered into a draw for two £25 tokens.

Personal and Professional Details (optional)
Please complete and amend as necessary.
Email: (free text)
Job title: (free text)
Subject specialism, if relevant: (free text)
Which of the following describe your position? (Please select all that apply.)
(a) FTE/PT: Full-time/ part-time (one MCQ)
(b) Role: Academic/ pedagogic support/ ICT support (more than one may apply) (one MCQ)
(c) C0ontract type: Permanent/ short-term contract/ hourly paid (one MCQ)
(d) Gender: male/ female (one MCQ)
(e) Age**:** 21-30/ 31-40/ 41-50/ 51-60/ 61-70 (one MCQ)
(f) Highest qualification held: (free text) (one MCQ)

---

1. Which of the following statements most accurately describes your experience with CAA?
(a) I *currently* use CAA, advise on the use of CAA or support CAA
(b) I *do not* use CAA, advise on the use of CAA or support CAA (one MCQ)
(c) I have used, advised on, or supported CAA in the past, *but no longer do so*.

2. Do you intend to use CAA in the future? Yes/ No (one MCQ)

3. If you teach, are you currently using computer-aided learning (CAL) in your teaching, excluding word processing and spreadsheets? Yes/ No (one MCQ)

4. Does your institution provide CAA support for academics? Yes/ No (one MCQ)
If so,
(a) Where is this located? Please select all that apply: As a central unit/ Within faculties/ within academic departments/ (one MRQ)
Elsewhere (please specify) (free text)
(b) Does your institution have a dedicated CAA officer(s)? Yes/ No
(c) Does your institution have a dedicated CAA department Yes/ No

5. If you teach, how likely would you be to use CAA IF …
Please enter a number from those listed below:
1 = very unlikely **2** = unlikely **3** = neutral **4** = likely **5** = very likely
(a) You had to create a test AND computerise it YOURSELF (one MCQ)
(b) You created a test BUT SOMEONE ELSE computerised it for you (one MCQ)
(c) Tests were available BUT you had to computerise them YOURSELF (one MCQ)
(d) Tests were available BUT SOMEONE ELSE computerised them for you (one MCQ)
(e) Appropriate computerised tests were already available for use (one MCQ)

6. In your view, does CAA save academics' time? Yes/ No (one MCQ)
a. If so, has this meant a significant shift in the workloads of other staff? (free text)
b**.** Can you say for whom, how and roughly the number of extra hours per week? (free text)

7. (a) Please list any advantages to using CAA that you have identified: (free text)
(b) Please list any disadvantages to using CAA that you have identified: (free text)

8. What do you see as the critical success factors for the implementation of CAA?
(a) At the level of the individual academic: (free text)
(b) At the level of the institution: (free text)

9. What do you see as the main obstacles to the successful implementation of CAA?
(a) At the level of the individual academic: (free text)
(b) At the level of the institution: (free text)

10. What do you perceive to be the attitude of each of the following groups towards CAA:
Please enter a number from those listed below:
1 = very negative **2** = negative **3** = neutral **4** = positive **5** = very positive
(a) Students (one MCQ)
(b) Academic staff (one MCQ)
(c) Senior management (one MCQ)
(d) External examiners (one MCQ)
(e) Technical staff (one MCQ)

11. Would any of the following be useful in supporting your use of CAA?
(For each, please indicate how)
(a) Staff development (free text)
(b) Institutional support (free text)
(c) National support (free text)
(d) Hardware provision (free text)
(e) Software provision (free text)

12. What future developments in CAA would you like to see? (free text)

If you CURRENTLY USE CAA, please complete the rest of the questionnaire. IF YOU DO NOT, please go to the final survey section which starts at Q.23 and which include the Survey Feedback Details section.

---

14. a. When did you start using CAA? (Year pick box- 1984➔2004??)
b. Can you say why you started using CAA? (free text)

15. Do you use question banks? Yes/ No
(a) If so, can you give any details? (free text)

16. Would you be interested in sharing questions with academics at other institutions? Yes/ No
(a) If so, can you give any details? (free text)

17. Have you evaluated your students' use of CAA? Yes/ No
(a) If so, can you give any details? (free text)

18. Have you ever used CAA with students with special needs? Yes/ No
(a) If so, can you give any details? (free text)

19. Please state the approximate number of computer-assisted assessments which you have delivered this year? None//6-10/11-20/21-30/31-50/51-100/>100
If you have delivered computer-assisted assessments this year, please summarise them:
(a) Subjects (free text)
(b) How many assessments were at the level of:
(i) Undergraduate Year 1? (Numeric, integer, default 0)
(ii) Undergraduate Year 2? (Numeric, integer, default 0)
(iii) Undergraduate Year 3 (or above) (numeric, integer, default 0)
(iv) Undergraduate Year 3 (or above) (numeric, integer, default 0)
(v) Postgraduate level? (numeric, integer, default 0)
(c) How many assessments were:
(i) Diagnostic- to identify pre-course knowledge? (Numeric, integer, default 0)
(ii) Formative- to assist in the learning process? (Numeric, integer, default 0)
(iii) Summative- to assess post-course knowledge? (Numeric, integer, default 0)
(iv) Other- please specify (free text)
(d) How many assessments were invigilated? (Numeric)
(e) Which question types have you used *this year*? Multiple-choice/ multiple-response/ text input/ numeric input/ graphical hot spots/ audio/video /other (free text)

(f) Please indicate the typical class size for CAA assessments? (free text)
(g) What other assessments are used in this module? essay – coursework/ essay – exam/ short answer questions/ lab report/ presentation/ objective test/ worksheets/ other (please specify) (free text)
(h) Please indicate the typical weighting (%) of the CAA within the module? (free text)

20. Do you receive support from any of the following for your use of CAA? (Please specify what form this support takes, e.g. funding, time released, staff, additional hardware/software resources.)
(a) Department (free text)
(b) Faculty (free text)
(c) Institution (free text)
(d) External (free text)
(e) Other (free text)

21. What CAA software packages are you using? Please list the packages and indicate which delivery method they relate to (summative/formative etc.) (free text)

22. What do you see as the particular advantages and disadvantages of the CAA software you use? (free text)

---

23. Which of the following statements describe the experience of the staff at your institution with CAA? Choose one: A significant percentage (20% or more) currently uses CAA/ Only a small group of enthusiasts use CAA/ No-one uses CAA/ Some have used CAA in the past, but no longer do so/ Some may be using it, but I am not aware of their use. (one MCQ)

24. (a) Does your institution already provide an institution-wide Virtual Learning Environment (VLE) such as Blackboard or WebCT? No/ Blackboard/ WebCT/ Other VLE (one MCQ)
(b) If so, do you think it has: encouraged people to use CAA/ *discouraged* people from using CAA/ Made no discernable difference to the uptake of CAA
(c) Would you like to be able to export quizzes from your VLE to a CAA system? Yes/ No
(d) What impact is the VLE making on the way you use CAA? (free text)

25. Interoperability standards:
IMS Question and Test Interoperability (QTI) is one specification for a standard way of sharing assessment data. IMS QTI is designed to make it easier to transfer information such as questions, tests and results between different software applications.
(a) Are you already aware of CAA interoperability standards such as the IMS QTI specification? Very aware/ Moderately aware/ Not really aware/ Not at all aware
(b) How important to you is the ability to 'future proof' CAA interoperability, such as the ability to transfer questions and assessments from one CAA system to another? Very important/ Moderately important/ Not really important/ Not at all important (one MCQ)
(c) What impact is interoperability making on the way you use CAA? (free text)

26. To what extent do you agree with the following statements
1 = strongly disagree **2** = disagree **3** = not sure **4** = agree **5** = strongly agree
Please enter a number from those listed above
(a) CAA allows for in-depth statistical analysis of examination questions (e.g. facility and discrimination). (one MCQ)
(b) CAA enables the generation of a wide range of reports analysing student performance. (one MCQ)
(c) CAA exams entail fewer security risks than paper exams. (one MCQ)
(d) CAA is more costly than paper-based assessment methods. (one MCQ)
(e) CAA is more time-consuming than paper-based assessment methods. (one MCQ)
(f) It is possible to test lower order learning, such as knowledge and comprehension, using objective tests. (one MCQ)
(g) It is possible to test higher order learning, such as critical analysis and evaluation, using objective tests. (one MCQ)
(h) Computerised marking saves academic staff a significant amount of time. (one MCQ)
(i) Training in CAA software and pedagogy should be available centrally within an institution. (one MCQ)
(j) Support staff should be solely responsible for the technical and operational aspects of CAA. (one MCQ)

(k) CAA offers greater objectivity in marking than tutor-marked assessments. (one MCQ)
(l) Student anxiety about using computers is a significant problem with CAA. (one MCQ)
(m) Academic staff anxiety about using computers is a significant problem with CAA. (one MCQ)
(n) Creating good CAA questions requires considerable time and effort. (one MCQ)
(o) Academic staff benefit from writing appropriate CAA questions (e.g. encourages careful consideration of assessment; enhances question design skills). (one MCQ)
(p) An important advantage of formative CAA is to allow students to work at their own pace and as frequently as necessary. (one MCQ)
(q) CAA significantly aids learning and revision. (one MCQ)
(r) CAA offers a wide range of question types. (one MCQ)
(s) CAA can only be used to test some disciplines. (one MCQ)
(t) CAA offers the potential to test a broad range of subject knowledge. (one MCQ)
(u) CAA enables tutors to offer more feedback than is possible with paper-based methods. (one MCQ)
(v) CAA improves the speed of feedback of results and comments to students. (one MCQ)
(w) Objective tests result in inflated scores due to guessing. (one MCQ)
(x) Objective testing is a good way to assess material typically found in levels one/two (eg. first and second year U/G) modules. (one MCQ)
(y) Objective testing is a good way to assess material typically found in level three (eg. final year U/G) or P/Grad. modules. (one MCQ)
(z) It is desirable to incorporate multimedia applications (film, audiotape, photographs, movable objects) into assessment. (one MCQ)

This is the end of the full edition of the 2004 national CAA Survey. We would like to thank you giving your time and effort. As a small token of our appreciation we will enter your email address into a draw for two £25 Book Tokens. The draw will take place at ALT-C in September 2004,

The results of this survey will be published in a variety of formats, including electronic publications available from the TOIA website.

Would you like to receive further information about results of the survey, other project activities and CAA developments, please : Yes/No (one MCQ)

- **If there are any aspects of CAA you are particularly interested in please detail them below:** (free text)
- **Can we contact you by telephone or email to follow up on your responses?** Yes/ No (one MCQ)

If so, suitable days and times to call: (free text)

Core Edition of the UK Survey Questionnaire (2004)

Thank you for taking the time to answer this questionnaire. All responses will be kept confidential and the raw data deleted as soon as it has been coded. If you have any queries about questions, please contact us on 023 8059 2326 or email wiw@soton.ac.uk
All completed questionnaires received by the end of June 2004 will be entered into a draw for two £25 tokens.

Personal and Professional Details (optional)
Please complete and amend as necessary.
Email: (free text)
Job title: (free text)
Subject specialism, if relevant: (free text)
Which of the following describe your position? (Please select all that apply.)
(a) FTE/PT: Full-time/ part-time (one MCQ)
(b) Role: Academic/ pedagogic support/ ICT support (more than one may apply) (one MCQ)
(c) C0ontract type: Permanent/ short-term contract/ hourly paid (one MCQ)
(d) Gender: male/ female (one MCQ)
(e) Age**:** 21-30/ 31-40/ 41-50/ 51-60/ 61-70 (one MCQ)
(f) Highest qualification held: (free text) (one MCQ)

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1. Which of the following statements most accurately describes your experience with CAA?
(a) I *currently* use CAA, advise on the use of CAA or support CAA
(b) I *do not* use CAA, advise on the use of CAA or support CAA
(c) I have used, advised on, or supported CAA in the past, *but no longer do so*.

2. Do you intend to use CAA in the future? Yes/ No (one MCQ)

3. If you teach, are you currently using computer-aided learning (CAL) in your teaching, excluding word processing and spreadsheets? Yes/ No

4. Does your institution provide CAA support for academics? Yes/ No (one MCQ)
If so,
(a) Where is this located? Please select all that apply: As a central unit/ Within faculties/ within academic departments/ (one MRQ)
Elsewhere (please specify) (free text)
(b) Does your institution have a dedicated CAA officer(s)? Yes/ No (one MCQ)
(c) Does your institution have a dedicated CAA department Yes/ No (one MCQ)

6. In your view, does CAA save academics' time? Yes/ No
a. If so, has this meant a significant shift in the workloads of other staff? (Yes/ No)

7. (a) Please list any advantages to using CAA that you have identified: (free text)
(b) Please list any disadvantages to using CAA that you have identified: (free text)

8. What do you see as the critical success factors for the implementation of CAA?
(a) At the level the individual academic: (free text)
(b) At the level of institutions: (free text)

9. What do you see as the main obstacles to the successful implementation of CAA?
(a) At level of the individual academic: (free text)
(b) At the level of institutions: (free text)

10. What do you perceive to be the attitude of each of the following groups towards CAA: Please enter a number from those listed below:
1 = very negative **2** = negative **3** = neutral **4** = positive **5** = very positive
(a) Students (one MCQ)
(b) Academic staff (one MCQ)
(c) Senior management (one MCQ)
(d) External examiners (one MCQ)
(e) Technical staff (one MCQ)

12. What future developments in CAA would you like to see? (free text)

If you CURRENTLY USE CAA, please complete the rest of the questionnaire. IF YOU DO NOT, please go to the final survey section which starts at Q.23 and which include the Survey Feedback Details section.

---

14. When did you start using CAA? (Year pick box- 1984➔2004??)

15. Do you use question banks? Yes/ No (one MCQ)

16. Would you be interested in sharing questions with academics at other institutions? Yes/ No (one MCQ)

19. Please state the approximate number of computer-assisted assessments which you have delivered this year? None//6-10/11-20/21-30/31-50/51-100/>100 (one MCQ)
If you have delivered computer-assisted assessments this year, please summarise them:
(a) Subjects (free text)
(b) How many assessments were at the level of:
(i) Undergraduate Year 1? (Numeric, integer, default 0)
(ii) Undergraduate Year 2? (Numeric, integer, default 0)
(iii) Undergraduate Year 3 (or above) (numeric, integer, default 0)
(iv) Undergraduate Year 3 (or above) (numeric, integer, default 0)
(v) Postgraduate level? (numeric, integer, default 0)
(c) How many assessments were:
(i) Diagnostic- to identify pre-course knowledge? (Numeric, integer, default 0)
(ii) Formative- to assist in the learning process? (Numeric, integer, default 0)
(iii) Summative- to assess post-course knowledge? (Numeric, integer, default 0)
(iv) Other- please specify (free text)
(d) How many assessments were invigilated? (Numeric)
(e) Which question types have you used *this year*? Multiple-choice/ multiple-response/ text input/ numeric input/ graphical hot spots/ audio/video (one MRQ)
/other (free text)
(f) Please indicate the typical class size for CAA assessments? (free text)
(g) What other assessments are used in this module? essay – coursework/ essay – exam/ short answer questions/ lab report/ presentation/ objective test/ worksheets/ other (please specify) (free text)
(h) Please indicate the typical weighting (%) of the CAA within the module? (free text)

21. What CAA software packages are you using? Please list the packages and indicate which delivery method they relate to (summative/formative etc.) (free text)

22. What do you see as the particular advantages and disadvantages of the CAA software you use? (free text)

---

23. **Which of the following statements describe the experience of the staff at your institution with CAA?** Choose one: A significant percentage (20% or more) currently uses CAA/ Only a small group of enthusiasts use CAA/ No-one uses CAA/ Some have used CAA in the past, but no longer do so/ Some may be using it, but I am not aware of their use. (one MCQ)

24. (a) Does your institution already provide an institution-wide Virtual Learning Environment (VLE) such as Blackboard or WebCT? No/ Blackboard/ WebCT/ Other VLE (one MCQ)
(b) If so, do you think it has: encouraged people to use CAA/ *discouraged* people from using CAA/ Made no discernable difference to the uptake of CAA
(c) Would you like to be able to export quizzes from your VLE to a CAA system? Yes/ No
(d) What impact is the VLE making on the way you use CAA? (free text)

25. Interoperability standards:
IMS Question and Test Interoperability (QTI) is one specification for a standard way of sharing assessment data. IMS QTI is designed to make it easier to transfer information such as questions, tests and results between different software applications.
(a) Are you already aware of CAA interoperability standards such as the IMS QTI specification? Very aware/ Moderately aware/ Not really aware/ Not at all aware
(b) How important to you is the ability to 'future proof' CAA interoperability, such as the ability to transfer questions and assessments from one CAA system to another? Very important/ Moderately important/ Not really important/ Not at all important (one MCQ)
(c) What impact is interoperability making on the way you use CAA? (free text)

This is the end of the Core edition of the 2004 national CAA Survey. We would like to thank you giving your time and effort. As a small token of our appreciation we will enter your email address into a draw for two £25 Book Tokens. The draw will take place at ALT-C in September 2004,

The results of this survey will be published in a variety of formats, including electronic publications available from the TOIA website.

- **Would you like to receive further information about results of the survey, other project activities and CAA developments, please :** Yes/No
- **If there are any aspects of CAA you are particularly interested in please detail them below:** (free text)
- **Can we contact you by telephone or email to follow up on your responses?** Yes/ No
  If so, suitable days and times to call: (free text)

Appendix D: Phase 3 PowerPoint presentation

Modelling CAA uptake in Higher Education

Bill Warburton

0. Introduction

Computer-assisted assessment (CAA) has been broadly defined as the application of computer technology to assessment tasks (Bull & McKenna, 2004).

This study focuses specifically on computer-based assessment (CBA) which means that both distribution and marking are automated.

The principal research questions are

1. What are the dynamics of institutional uptake?
2. What are the metrics of 'good' implementations?
3. What are good ways to implement CAA?

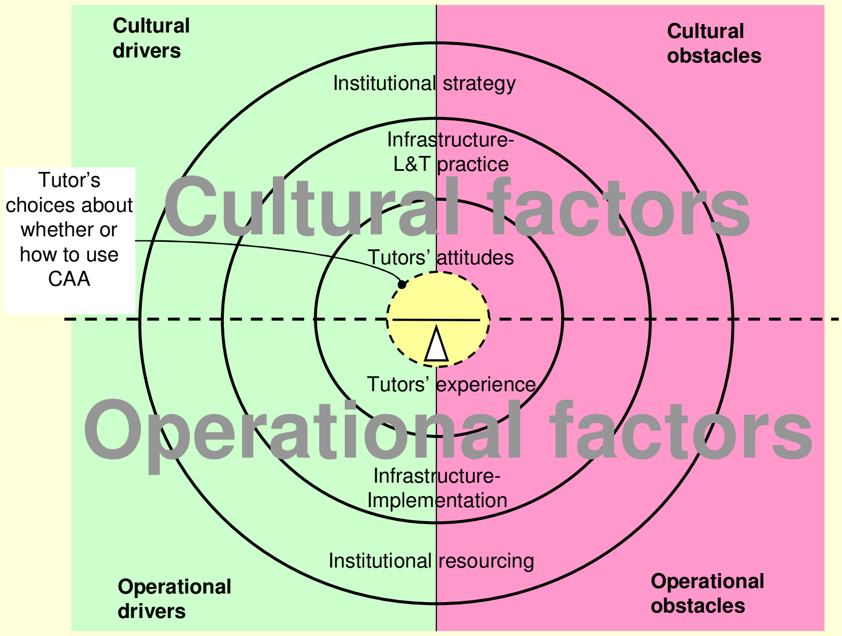
1. What are the dynamics of institutional uptake?

'Uptake' is complex but could be portrayed as the aggregate profile of individual tutors' choices

- Tutors' decisions are heavily conditioned by
  - their propensities (e.g. risk-averse or otherwise)
  - their experience (e.g. productivity gains seen, or not)
- These are in turn conditioned by infrastructure
  - Learning and Teaching practices (e.g. procedures)
  - Physical infrastructure (e.g. centralised CAA system)
- Which are in turn conditioned by institutional
  - Strategy (e.g. drive for centralised DP systems)
  - Resourcing (e.g. funding centralised CAA system)

1.1 Disposition of factors affecting uptake

According to Kurt Lewin, organisational change requires either a net increase in driving forces or a net decrease in restraints (Lewin, 1944)



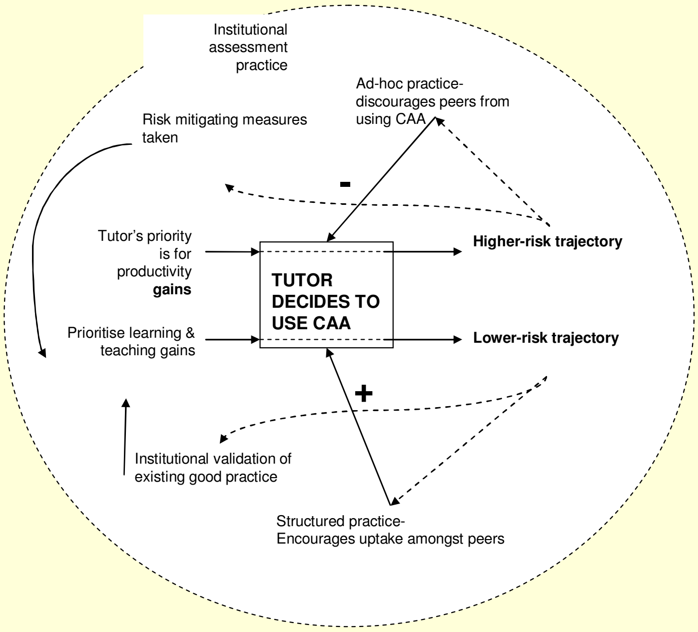
1.2 Dual path model of CAA uptake

Tutors deciding to use CAA appear initially to follow one of two paths:

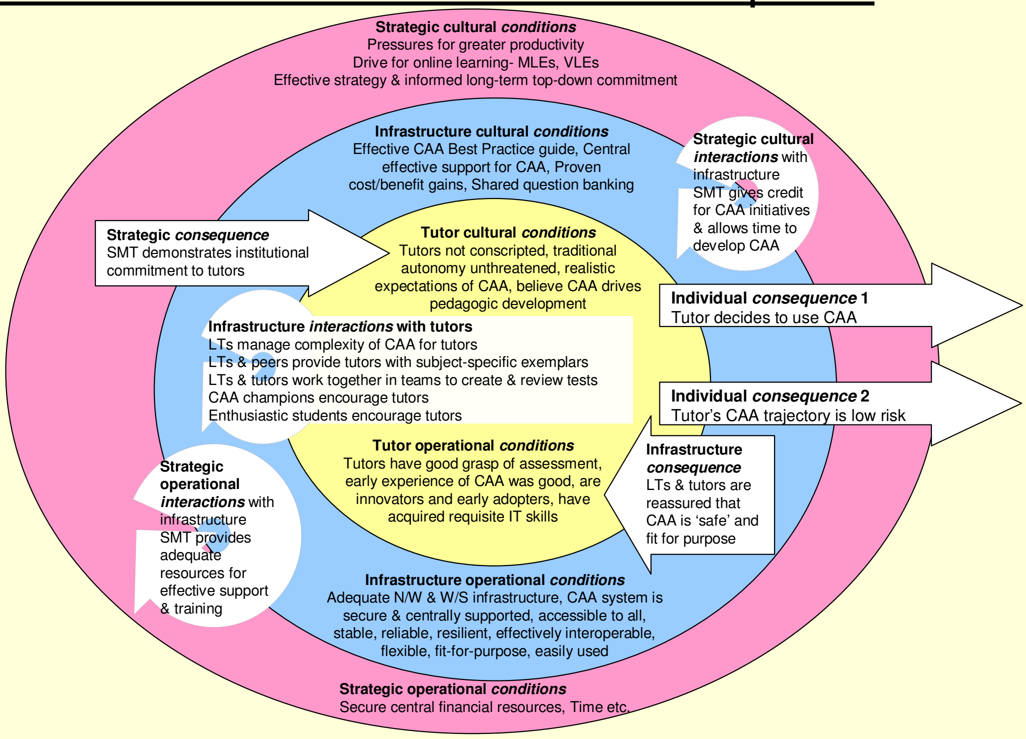
•A *lower-risk* path that is conditioned by tutors prioritising improvements in learning and teaching effectiveness over possible productivity gains

•A *higher-risk* path conditioned by tutors prioritising productivity gains over possible learning and teaching benefits

Tutors with a higher-risk profile benefits from risk mitigation measures taken by support personnel



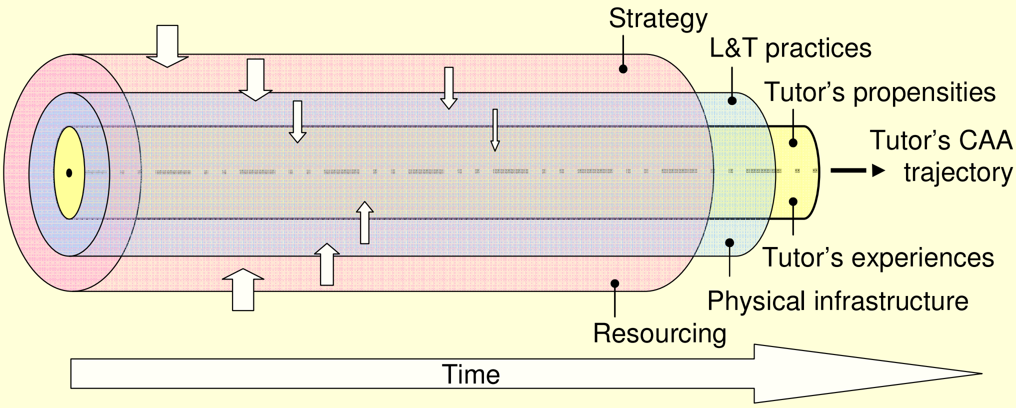
1.3 Model of factors in 'low risk' uptake



1.4 A Longitudinal Model- Effects on Tutors

(Warburton's Arctic Roll)

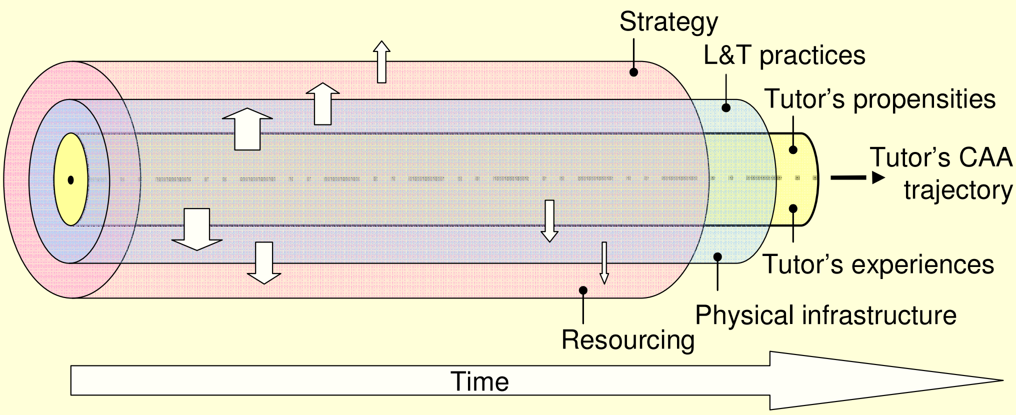
- A tutors' use of CAA follows a trajectory through time
- Trajectories are influenced by well-known factors (e.g. Bull & McKenna (1999), Warburton's Egg)
- Tutors' practice is insulated from external influences by concentric layers of institutional & infrastructural inertia



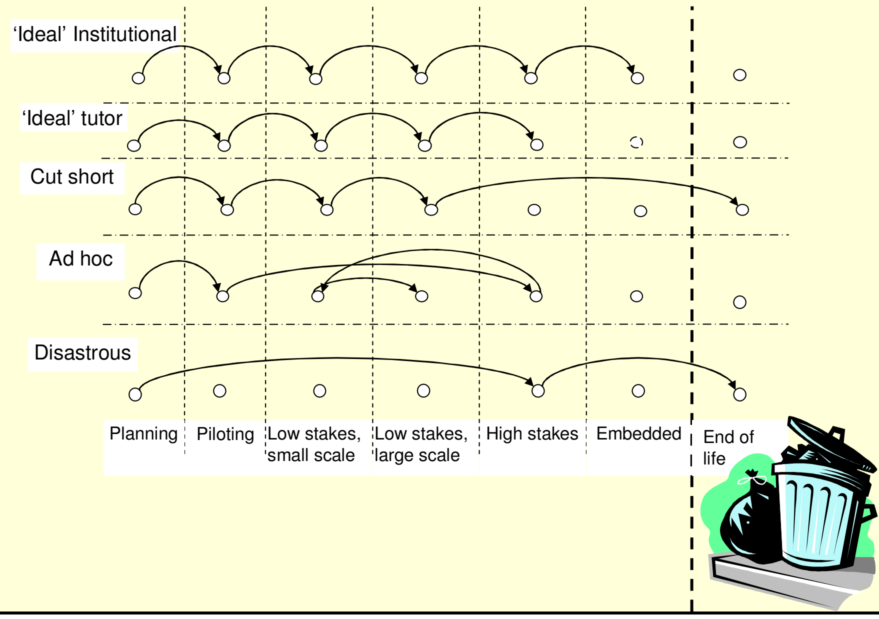
1.5 A Longitudinal Model- Tutors' Effects

Tutors' trajectories have an attenuated reciprocal influence on

- Institutional strategy & resourcing
- Learning & Teaching practices
- Physical infrastructure



1.6 Some observed CAA trajectories



2. What are the metrics for 'success'?

***Whose* notion of success?**

- Tutors?
- Learning technologists?
- QA staff?
- Senior management?
- Students?

There's no problem in identifying failure…

But 'success' is hard to pin down…

Success on what *scale*?

- Individual tutors?
- Faculty/department?
- Institutional?

Metrics of success on an institutional scale…

- 'Width' of practice (in terms of **scale)**
  - Range of subject use (Hum/Qual/Quant)
  - Range of use (diag/form/sum)
  - Range of items types
  - Number of users
  - Number of tests taken
- Level of integration with corporate MIS systems e.g. MLE
- 'Embeddedness' i.e. is taken for granted & has become 'invisible' and is (for some well-informed specialists) the key metric of success

3. What are good ways to implement CAA?

- Well, it seems to depend…
  - For centralised institutions, centralise and embed
  - For devolved institutions, offer a central service but permit fit-for-purpose variety
- However, in general it is vital to…
  - Provide time for tutors to acquire pertinent skills
  - Maintain good links with SMT
  - Maintain simple and effective policy and procedures
  - Test CAA systems thoroughly
  - Provide a secure, stable, scalable, accessible infrastructure
  - Maintain links between tutors and CAA specialists

Finally- some questions

1. Is this **coherent-** i.e. does it make sense?
2. Does it 'ring true' as a **description**?
3. To what extent does it **explain** CAA uptake?
4. Given detailed knowledge of an institution's processes and priorities, what kinds of **predictions** should be possible?
5. Are there any obvious **gaps** in the theory?

Appendix E: Critical factors in US K-12 uptake

Critical factors: Hambrick's (2002) Delphi analysis

1. Planning (3O, 2C)
1.1 Where does the funding come from? (O)
1.2 Is the online assessment system linked to major accountability legislation? (O)
1.3 What are the cost & financial implications? (O)
1.4 Is the purpose of moving towards online assessment efficiency or cost, or [is] the purpose to support evaluation research and new ways to teach and learn? (C)
1.5 What are the political implications for moving towards online assessment? (C)
2. Technology system requirements (10O)
2.1 Are the existing allocation (*sic.*) of computers to classroom sufficient to support several rounds of testing each year? (O)
2.2 What type of monitor and resolution will be made available? (O)
2.3 What type of software will be needed for the assessment? (O)
2.4 How will the software be upgraded? (O)
2.5 How can we generate comparable inferences across students and schools when variations in school equipment may cause items to display differently from one student to the next, possibly affecting performance? (O)
2.6 Will the web site have the capacity to serve the maximum number of simultaneous users? (O)
2.7 Will the monitor and resolution be consistent for each student taking the test? (O)
2.8 How can you accurately authenticate the individual who is taking the test at the other end of the line? (O)
2.9 How can we deliver assessments dependably given the unreliable nature of computers and the Internet and the limited technical support available in most schools? (O)
2.10 Will the system be available when you need it? (O)
3. Access (4O)
3.1 What procedures will be in place to ensure that the content assessed is representative of all students' experiences? (O)
3.2 What type of procedures will be in place to limit access to the test items by unauthorised individuals or at unauthorised times? (O)
3.3 Who will have access to the test scores? (O)
3.4 Who will have access to the system? (O)
4. Accommodations (2O)
4.1 What accommodations are necessary for access for students? (O)
4.2 How will the technology applications be balanced with students needs (cultural, physical and/or language)? (O)
5. Professional Development (2C)
5.1 What is the level of faculty proficiency or skills with technology? (C)
5.2 What type of professional development is needed? (C)
6. Online Assessment Formats (1O)
6.1 Technology can support alternative methods of measurement (such as simulations and adaptive testing). What type of method would be most beneficial to gather student data based on the assessment items? (O)
7. Evaluation of the system (4O, 1C)
7.1 How will the information be used to revise and improve the online assessments? (O)
7.2 How will the information be used to determine the value added by the online assessments? (C)
7.3 What type of summative evaluation will be implemented to revise and improve the online assessments? (O)
7.4 What type of summative evaluation will be implemented to determine if the online assessments are meeting the intended goals? (O)
7.5 What information will assist with the evaluating, the reliability, the validity and effectiveness of the online assessments in terms of student learning (*sic.*)? (O)
8. Administrative issues (2O)
8.1 What are the test and data security implications for using the computers for multiple purposes? (O)
8.2 What type of procedures in terms of administrative and/or technical support will be in place to ensure the reliability of the system? (O)

9. Ethical/Legal Issues (3O, 1C)
9.1 What type of procedures needs to be developed and in place to assist with the litigation process? (O)
9.2 What recourse do education leaders (at all levels) and individuals have to petition the online assessments for discrepancies? (O)
9.3 What type of procedures needs to be developed and implemented to address the ethical and legal issues? (O)
9.4 What are the policy and political issues that need to be considered in conjunction with the standards and accountability movement in the state, district, and/or school? (C)
10. Student Population (2O, 2C)
10.1 What are the characteristics of the student population being assessed? (C)
10.2 Do different students understand the same question in the same way? (C)

Appendix F: Tutors' Decisions to use CAA

1. Institutional strategy & policy

1	31	**Drivers- Strategy & policy**			
1	31	1	Drive for online learning- MLEs, VLE		
1	31	1	7	Integration with MLE	
1	31	2	Top-down long-term commitment		
1	31	2	1	SMT enthusiasm	
1	31	2	2	Supports innovation	
1	31	2	3	SMT confidence in staff	
1	31	2	4	Commitment to MLE	
1	31	2	5	CAA is as important as the VLE	
1	31	2	7	Tap funding initiatives	
1	31	2	9	Kept aware of developments	
1	31	2	10	SMT understands CAA issues	
1	31	2	13	Co-operative registry	
1	31	2	14	Requires MIS to support CAA	
1	31	2	16	Minimises misuse	
1	31	2	17	Manages impaired performance claims	
1	31	2	104	Seal of QA approval – it is valid!	
1	31	3	Clear inst L&T strategy inc QA of CA		
1	31	3	1	Allow subject-specific systems	
1	31	3	2	Integration of CAA with Inst Procedure	
1	31	3	3	Allow range of sophistication	
1	31	3	4	Improve student retention	
1	31	3	5	Dissemination of good practice	
1	31	4	Effective strategy to manage change		
1	31	4	1	Preparedness for change	
1	31	4	2	Accountability	
1	31	4	6	HEI policy shift to centralised ICT	
1	31	4	43	Overcoming institute barriers	
1	32	**Obstacles- Strategy & policy**			
1	32	1	Inertia		
1	32	1	2	Uncommited approach to L&T	
1	32	1	5	Dirigisme, Ethos	
1	32	1	5	1	Management hostility
1	32	1	5	2	SMT with vested interests
1	32	1	5	4	Obstructive managerial policies
1	32	1	22	Conservatism	
1	32	1	22	4	Conservative colleagues
1	32	1	22	18	Unfamiliarity and fear of change

1	32	2	Naivety		
1	32	2	1	Ignorance of core issues	
1	32	2	2	Financial naivety	
1	32	2	6	Unrealistic expectations of SMT	
1	32	2	12	Naïve view of CAA as a quick fix	
1	32	2	24	Ignorance of costs & benefits	
1	32	3	Strategic constraints		
1	32	3	1	Devolved structures	
1	32	3	2	Failure to include CAA in exam P&P	
1	32	3	3	RAE vs L&T	
1	32	3	4	Reliance on individual tutors	
1	32	3	6	Reliance on IT departments	
1	32	6	Ineffective senior management		
1	32	6	4	Ineffective change management	
1	32	6	4	2	HEI CAA commitment is ineffectual
1	32	6	4	3	Changes required to procedures
1	32	6	4	4	All change is difficult
1	32	6	4	5	HEI ICT policy has been haphazard
1	32	6	4	7	HEIs use in-house skill inefficiently
1	32	6	4	15	Cultural change
1	32	6	7	Lack of direction from SMT	
1	32	6	7	1	Lack of influential champions
1	32	6	7	4	I don't think any HEIs are serious
1	32	6	7	8	Failure to standardize tools
1	32	6	7	15	Failure to motivate staff in LT
1	32	6	7	39	Fear of trespassing
1	32	11	Entrenched scepticism		
1	32	11	1	Scepticism about fitness for purpose	
1	32	11	2	Tutor reluctance to try it out	
1	32	11	3	Once a sceptic always a sceptic	
1	32	11	4	Academic non-commital	
1	32	11	7	Skeptical academics~	
1	32	11	8	Skepticism re quality of CAA SW	
1	32	11	9	Lack of confidence in CAA	

2. Institutional resourcing

2	33	Drivers- Resourcing				
2	33	5	Allowance of time to develop CAA			
2	33	5	3	Time released		
2	33	5	6	To resource staff development		
2	33	5	10	staff secondment scheme		
2	33	5	18	Staff to input questions		
2	33	5	19	Time needed to~		
2	33	5	19	1	Initial time investment paid off	
2	33	5	19	2	Time to master software	
2	33	5	19	3	Time to write questions	
2	33	5	19	4	time to review assessments	
2	33	6	Pressure for more productivity			
2	33	6	1	Asked to by senior managers		
2	33	6	2	Time savings & maintained standards		
2	33	6	101	CAA uptake driven by large depts		
2	33	7	Secure central financial resourcing			
2	33	7	3	Upfront costs		
2	33	7	6	Direct funding of CAA staff		
2	33	7	12	CAA SW Licences		
2	33	7	17	Well-resourced infrastructure		
2	33	7	113	appreciating CAA resource hungry		
2	33	7	115	Affordable tools		
2	33	7	152	Support at Faculty level		
2	33	8	Well-resourced Support & Training			
2	33	8	2	Good tech and admin support		
2	33	8	5	Centralised support		
2	33	8	10	course designing objective questions		
2	33	8	11	IT Resourcing		
2	33	8	26	training provided		
2	33	8	117	Provision of support		
2	33	8	117	1	Training for Authoring	
2	33	8	117	1	15	Good items require training
2	33	8	117	2	Technical- inc use of CAA SW	
2	33	8	117	2	6	Technical CAA workshops
2	33	8	117	3	providing the resources to do it	
2	33	8	117	4	Cooperative Registry	
2	33	8	117	8	Having support staff available	
2	33	8	155	Staff Development		
2	33	8	155	2	Timesaving following initial effort	
2	33	8	155	4	Needs to be ongoing	
2	33	8	155	7	Widens CAA community	
2	33	8	155	8	training in assessment design	
2	33	8	155	9	Training in use of software	
2	33	8	155	10	Assumes tutors want to use CAA	
2	33	8	155	13	What work, what doesn't	
2	33	8	155	17	Assessment not an afterthought	
2	33	9	Credit given for CAA initiatives			

2	34	Obstacles- Resourcing			
2	34	5	No allowance of time to develop CAA		
2	34	5	1	No time to prepare and test material	
2	34	5	2	No time to get tech support	
2	34	5	7	No time to innovate	
2	34	5	11	No time to learn CAA tools	
2	34	5	13	no overall time saving	
2	34	6	No credit given for CAA initiatives		
2	34	6	2	Promotion only for RAE work	
2	34	7	Insecure financial resourcing		
2	34	7	1	Cost of support	
2	34	7	2	True cost of running CAA service	
2	34	7	3	Increased staffing	
2	34	7	104	No money foils Strategic plan	
2	34	7	107	Cheapness compromises L&T quality	
2	34	7	108	Initial cost	
2	34	7	110	Centralised services a visible cost	
2	34	7	124	Recurring costs	
2	34	7	124	13	financial and HR limitations
2	34	8	Lack of Support & Training		
2	34	8	1	Lack of support	
2	34	8	1	1	Speed of technology change
2	34	8	1	28	Lack of tech support
2	34	8	1	104	Lack of IT support
2	34	8	27	Lack of training	

3. Infrastructure- L & T practices

3	21						**Drivers- L&T practices**
3	21	1					Target CAA at e-Modules
3	21	2					CAA complexity appreciated & managed
3	21	2	5				3x longer to publish 1st timers test
3	21	2	107				Technical issues resolved later
3	21	3					Staff collaborate in teams
3	21	3	2				Teamwork- creating & reviewing items
3	21	3	4				Encouragement from CAA champions
3	21	3	4	1			Support from experienced colleague
3	21	3	4	8			Use grows by Word of mouth
3	21	3	5				Foster a CAA user community
3	21	3	5	1			Critical mass
3	21	3	5	3			Cross-department liaison
3	21	3	5	140			encourage staff to look at potential
3	21	4					Pedagogic gains
3	21	4	1				Test wider range of knowledge
3	21	4	2				Fast feedback
3	21	4	3				CAA drives pedagogic improvement
3	21	4	11				Formative drills
3	21	4	11	7			Available 24-7 with instant feedback
3	21	5					Cost benefit efficiency gains
3	21	5	1				Benefits of automation
3	21	5	1	2			Flexibility
3	21	5	1	4			Avoid paper based system
3	21	5	1	21			Database accessibility
3	21	5	1	21	2		Capacity to edit
3	21	5	1	21	14		marks stored for the academic
3	21	5	1	21	15		Ease of updating information
3	21	5	5				Accurate assessment ~with less staff
3	21	5	61				Productivity gains
3	21	5	61	1			discovery of cd's from publishers~
3	21	5	61	1	23		Bundled books-LOs-assessment
3	21	5	61	2			Re-use of resources
3	21	5	61	2	4		Efficiency gains
3	21	5	61	2	25		Question Banks
3	21	5	61	2	25	1	Access to quality question content
3	21	5	61	2	25	2	QBs reduce initial obstacles
3	21	5	61	2	25	3	Share items across subjects
3	21	5	61	2	25	4	Maintaining QBs is time efficient
3	21	5	61	2	25	5	Want to routinely share items

3	21	10			clear CAA policies & procedures
3	21	10	1		Risk Management
3	21	10	1	1	Areas of vulnerability are covered
3	21	10	1	2	Have Plan B
3	21	10	1	3	Smooth transition to Plan B
3	21	10	1	4	Substitute formative marks
3	21	10	1	5	Stress testing
3	21	10	2		Delivery
3	21	10	2	1	Pre-delivery testing of WSAs
3	21	10	2	2	Security built-in
3	21	10	2	3	Students thoroughly prepared for CAA
3	21	10	2	4	Adequate invigilation arrangements
3	21	10	3		Review
3	21	10	4		Authoring
3	21	10	5		Reporting
3	21	10	6		QA
3	21	10	7		Use as one element of asst regime
3	21	10	8		Exam Office shares load
3	22				**Obstacles- L&T practices**
3	22	1			Unaddressed CAA Practice issues
3	22	1	1		Geeky advice on software
3	22	1	2		'New wine in old wineskins'
3	22	1	3		Procedural gaps
3	22	1	3	1	No plan B
3	22	1	3	2	Bad process- interruptions
3	22	1	3	3	Bad process- WSs not tested
3	22	1	3	4	Bad process- WS area double-booked
3	22	1	3	5	No support from Exams Office
3	22	1	3	6	CAA exams difficult to reschedule
3	22	1	3	7	Students unprepared for CAA
3	22	1	3	8	SMEs don't test items fully
3	22	1	3	9	Rushed publication process
3	22	1	5		Onerous, unwieldy procedures
3	22	1	6		Invigilation
3	22	1	8		Concerns re interoperability
3	22	1	9		Inflexible
3	22	1	201		Interpretation of awkward BP guides
3	22	2			CAA complexity unappreciated
3	22	2	1		lack of understanding of issues
3	22	2	2		Missed details can be catastrophic
3	22	2	3		Unclear rationale for use
3	22	3			Tutors work in isolation
3	22	3	1		Q sharing impractical

3	21	5	61	2	25	6	Share items between institutions
3	21	5	61	2	25	7	Security-different test per attempt
3	21	5	61	3			Stable teaching portfolios
3	21	5	61	4			Demonstrable savings in tutors time
3	21	5	61	4	2		Saves time in short term
3	21	5	61	4	3		Time savings in long term
3	21	5	61	4	6		Speed, lighten assessment burden
3	21	5	61	4	6	1	Speed of result distribution
3	21	5	61	4	6	2	Administrative time savings
3	21	5	61	4	6	3	Speed of test distribution
3	21	5	61	4	6	4	Speed of marking
3	21	5	61	4	6	5	Speed of feedback
3	21	5	61	4	6	6	Speed of analysis
3	21	5	61	4	59		Time savings with large cohorts
3	21	5	61	5			Detailed stats reporting
3	21	5	61	6			Shifts assessment workload
3	21	5	61	6	1		Shift of workload to LT staff
3	21	5	61	6	2		Saves time at busy periods
3	21	5	61	8			CAA can be merged with other tests
3	21	5	61	19			Numeric drills with random variables
3	21	5	61	114			Cost effectiveness
3	21	5	61	114	5		cost-conscious department adopts CAA
3	21	5	61	114	7		no greater cost than Paper Based exam
3	21	6					Uptake increases uptake
3	21	7					Access to subject-specific exemplars
3	21	8					Enthusiastic student community
3	21	8	1				Access issues addressed
3	21	8	15				tech-savvy students increase demand
3	21	8	114				Student confident CAA good for them
3	21	9					Effective support for CAA
3	21	9	1				big project pays ICT staff support
3	21	9	2				Good support when problems occur
3	21	9	8				Support pitched at appropriate level
3	21	9	10				Pedagogical support
3	21	9	10	13			Someone else to input questions
3	21	9	11				Hardware support
3	21	9	14				Easily accessed support
3	21	9	15				Ongoing support

3	22	3	2		Multiple authoring hard to support
3	22	3	3		QBs develop slowly
3	22	3	4		Items not of uniform difficulty
3	22	3	5		No administrative support
3	22	3	6		CAA exams onerous but unsupported
3	22	3	7		Failure Fall-out isolates tutors
3	22	3	49		Unaware of success in other HEIs
3	22	4			Vociferous CAA critics
3	22	4	8		Horror stories
3	22	5			CAA application isolated
3	22	6			Subject-related difficulties
3	22	6	7		No subject-specific exemplars
3	22	6	7	1	Lack of of precedents
3	22	6	7	115	Lack of role models
3	22	7			Limitations of objective items
3	22	8			Unenthusiastic students
3	22	8	1		Reduces personal contact with tutor
3	22	8	2		students do not like it
3	22	8	3		Terra Incognita
3	22	8	4		Student misunderstandings
3	22	8	5		Computer anxiety
3	22	8	6		CAA-naive students make ICT errors
3	22	8	7		Students hate CAA problems
3	22	8	8		Some don't participate
3	22	8	9		CAA is not a real exam
3	22	8	10		Students prefer other asst modes
3	22	9			Fragmented support for CAA
3	22	9	1		Lack of proper training
3	22	9	2		Lack of timely support
3	22	9	3		Unmet need for Centralised staff
3	22	9	4		Lack of support from Registry
3	22	10			Inertia, 'mindsets'
3	22	106			CAA is a black hole
3	22	106	3		Every year changing software, Qmark
3	22	106	4		More payback from RAE work
3	22	106	5		Unproven cost benefit gains
3	22	106	5	6	Requires large cohort to be CostEffe
3	22	106	48		CAA resource-hungry
3	22	106	48	1	Large investment of time up-front
3	22	106	48	2	Length of time to implement a test
3	22	106	48	3	Administrative overheads
3	22	106	48	4	Invigilation costs
3	22	106	48	5	Low availability of 'practice' items
3	22	106	48	7	Inefficient use of resources
3	22	106	48	8	Need to modify imported QBs
3	22	106	48	33	Qs difficult &time consuming to writ
3	22	106	48	42	Running costs potentially high

3	21	9	16		Effective technical support
3	21	9	33		Effective training
3	21	9	33	2	Training in use of SW
3	21	9	33	7	need just-in-time CAA training
3	21	9	33	12	Training in the devt of assessments
3	21	9	33	18	staff training goes stale
3	21	9	33	19	staff training onerous but necessary
3	21	9	33	46	Initial training is vital
3	21	9	33	103	Supporting infrequent users
3	21	9	113		Encourage less enthusiastic staff
3	21	9	119		Centralisation of support
3	21	9	119	4	Central academic support using CAA
3	21	9	119	5	Specialist team
3	21	9	119	7	Devolved specialist support
3	21	9	119	34	Adhering to institutional guidelines

3	22	106	48	99	QA correcting CAA errors wastes time
3	101				Amphoteric- L&T practices
3	101	1			Increased uptake can be driver or ba
3	101	2			Time savings can be barrier or drive
3	101	3			Procedures can be obstacle or driver
3	101	5			Failures under-reported
3	101	6			More feedback- Unintended consequences
3	101	7			Wide curriculum tested can be obstacle
3	101	8			Restricted LO range becomes an asset

4. Infrastructure- Physical environment

4	23					**Drivers- Physical environment**
4	23	10				Robust ~centralised~ system
4	23	10	1			Central log-in
4	23	10	2			Well-maintained & updated syst
4	23	10	6			Economies- scale/performance
4	23	10	9			Must scale well
4	23	10	10			CAA SW that works everywhere
4	23	10	199			CAA worked very well
4	23	11				Easily used CAA system
4	23	11	1			CAA users not rocket scientists
4	23	11	2			Ease of Maintenance
4	23	11	3			easy to upload/ test assessment
4	23	11	3	10		Ease of updating tests
4	23	11	4			Ease of administration
4	23	11	5			Ease of test construction
4	23	11	6			Ease of migration
4	23	11	7			Trade-off Ease of Use & Function
4	23	11	9			Easy access to SW for all tutors
4	23	11	23			No more difficult than 'Word'
4	23	11	123			Standardisation
4	23	11	123	14		co-ordinated L&T interface
4	23	12				Flexible fit for purpose CAA system
4	23	12	8			Ongoing development
4	23	12	10			Flexibility
4	23	12	10	3		Show problem-solving
4	23	12	10	5		Support large banks
4	23	12	10	6		Wide range of QTs
4	23	12	10	7		Wide range of reports
4	23	12	10	16		Effective Interoperability for CAA
4	23	12	10	16	1	Tight integration with V~MLE
4	23	12	10	16	11	Conforms to QTI standard
4	23	12	10	18		Ease of integrating multimedia
4	23	12	47			Subject specific system
4	23	12	141			CAA Platform choice not crucial~
4	23	13				Secure central system
4	23	13	3			Audit trail of students progress
4	23	13	3	1		Test attempts reliably logged
4	23	13	3	2		Number of attempts logged
4	23	13	8			Central IT infrastructure
4	23	13	8	1		Disabled access centrally addressed
4	23	13	8	3		VLE Integration
4	23	13	8	10		version upgrade protection
4	23	13	8	109		Efficient student registration
4	23	15				Adequate NW & WS infrastructure
4	23	15	1			Robust Network
4	23	15	2			Mobile devices
4	23	15	3			WS provision
4	23	15	3	1		Reliable & easy access to WS
4	23	15	3	4		Want bigger WS areas

4	24						**Obstacles- Physical environment**
4	24	10					Lack of stable reliable CAA system
4	24	10	1				Concerns re system reliability
4	24	10	2				Complexity increases risk
4	24	10	3				Unresponsive vendors
4	24	10	4				Scaling issues
4	24	10	4	1			Service interruptions & fear of these
4	24	10	4	2			Multimedia can be slow to download
4	24	10	4	3			banned new users
4	24	10	4	4			Dependant on network server performance
4	24	10	4	5			Vulnerable to heavy loads
4	24	10	4	12			poor use of database
4	24	10	4	17			Restricted choice of browser
4	24	10	4	41			Unwieldy to scale up
4	24	10	5				Tools unsuitable for HE use
4	24	10	6				Experience of real failure
4	24	10	9				Support-intensive
4	24	10	14				Pace of change
4	24	10	18				ad hoc patches and fixes
4	24	11					Difficult to use CAA system
4	24	11	4				Difficult to reconcile CAA results
4	24	11	10				Unfriendly software
4	24	11	10	1			Awkward user interface
4	24	11	10	1	2		tedious inputting of tests
4	24	11	10	1	7		Restricted Q arrangement
4	24	11	10	1	8		Not intuitive
4	24	11	10	1	8	1	Learning curve & ease of use
4	24	11	10	1	19		Essay style items too awkward
4	24	11	10	1	44		Complex maths tests difficult
4	24	11	10	2			Awkward reporting interface
4	24	11	10	3			Awkward publishing process
4	24	11	10	4			Restricted Q design
4	24	11	10	5			Restricted F/B options
4	24	11	10	6			Restricted reports
4	24	11	10	13			Awkward participant user interface
4	24	11	116				Initial effort to become familiar
4	24	12					Inflexible shrink-wrap CAA system
4	24	12	1				Doesn't work everywhere
4	24	12	3				Unresponsive vendors
4	24	12	8				Standard SW constrains practice
4	24	12	8	1			No pause button
4	24	12	8	2			Attempts not logged
4	24	12	118				No One-size-fits-all solutions
4	24	13					Fragmented insecure/unsupported sy
4	24	13	2				Security concerns
4	24	13	2	1			Authentication issues
4	24	13	2	16			poor password encryption

4	23	15	3	6			Use public WS in shifts for CAA exam
4	23	15	3	7			Test large group with multiple sites
4	23	15	4				WS threat Mitigation
4	23	15	4	1			CAA weakness mitigated by procedures
4	23	15	4	2			BS7988 spacing impractical
4	23	15	4	3			Automated WS BS
4	23	15	4	3	1		WS bookings being automated
4	23	15	4	3	2		LecThs don't need booking sheets
4	23	15	4	3	5		Automated system puts onus on tutors
4	23	15	4	3	6		Automated system vulnerable
4	23	15	4	3	7		Automated WS BS not designed for CAA
4	23	15	4	4			Large QBs make retakes practical
4	23	15	4	5			Cheating minimised by short times
4	23	15	4	6			Test large cohorts in shifts
4	23	15	4	8			WS Admin officer
4	23	15	4	8	1		Manual systems more Resilient
4	23	15	4	8	2		Manual system more flexible
4	23	15	4	8	3		Manual process lacks checks
4	23	15	4	8	4		Able to resolve clashes manually
4	23	15	4	8	5		Liaises with Estates
4	23	15	4	8	6		Enjoys challenge
4	23	15	4	8	7		Satisfaction from making things possible
4	23	15	4	8	8		Enjoys liaising with the tutors
4	23	15	4	8	9		Process accommodates CAA exams
4	23	15	4	8	9	8	Added CAA button to booking form
4	23	15	4	8	10		Booking sheets a visible reminder

4	24	13	2	30				Invigilation worries
4	24	13	2	46				poor sppt compromises Security
4	24	13	2	111				Insecure infrastructure
4	24	13	14					Fragmented support ped/SW
4	24	13	112					Poor attitudes in MIS
4	24	13	119					Failure to centralise
4	24	13	119	1				lack of MLE
4	24	13	119	17				Not accessible to all students
4	24	15						Inadequate NW & WS infrastructure
4	24	15	1					WS-related Threats
4	24	15	1	1				Bad process-interruptions
4	24	15	1	2				Tutors irresponsible attitudes to WS
4	24	15	1	2	1			Tutor unprepared-more seats needed
4	24	15	1	2	2			Tutors make ad hoc changes
4	24	15	1	2	3			Tutors don't notify IT re CAA tests
4	24	15	1	2	4			Can go wrong when tutors careless
4	24	15	1	3				Process- WSs untested
4	24	15	1	4				Process- WS area double-booked
4	24	15	1	5				WSA SW availability a complex problem
4	24	15	1	5	4			CAA Exams resource-hungry
4	24	15	1	5	4	1		CAA exams need long slots
4	24	15	1	5	4	1	1	CAA needs 2x time
4	24	15	1	5	4	1	2	SpLD increases load
4	24	15	1	5	4	2		CAA exams need more seats
4	24	15	1	5	4	3		Big cohorts need long slots
4	24	15	1	5	5			CAA out-competed by L&T
4	24	15	1	5	5	1		Rising pressure on WS provision
4	24	15	1	6				Small QBs make retakes vulnerable
4	24	15	1	7				Need to ensure correct SW in WSA
4	24	15	2					computer networks not 100% reliable
4	24	15	4					Inadequate storage
4	24	15	5					High cost of infrastructure
4	24	15	34					Inadequate WS provision
4	24	15	34	1				Insufficient large WSAs
4	24	15	34	6				Costs of upgrading
4	24	15	34	104				Lack of control over student PCs

5. *Tutors' attitutudes & propensities*

5	11							**Drivers- Tutors Attitudes**
5	11	1						Feel supported by institution
5	11	2						Broad confidence in CAA system
5	11	2	1					Want to understand failures
5	11	2	4					Is it 'Fit for Purpose'
5	11	2	4	1				Confidence that CAA tests HLOs
5	11	2	4	2				Appropriate for subject
5	11	2	4	3				CAA fits courses that use quizzes
5	11	2	4	4				Fit for summative testing
5	11	2	4	5				Course uses continuous assessment
5	11	2	4	6				Use appropriate to context
5	11	2	4	7				Good for large cohorts
5	11	2	4	8				CAA fits ITC based courses
5	11	2	4	8	1			completely paperless module
5	11	2	4	9				Are standards maintained
5	11	2	4	12				Accommodates subject-specific practice
5	11	2	4	13				Matches intended LOs
5	11	2	4	21				Good correlation with other modes
5	11	2	4	30				Appropriate question types
5	11	2	5					Investments in CAA preserved
5	11	2	7					CAA improves L&T practice
5	11	2	7	5				Benefits
5	11	2	7	5	1			Anonymity
5	11	2	7	5	2			Facilitates Formative testing
5	11	2	7	5	3			Increased Validity
5	11	2	7	5	4			Benefits for students
5	11	2	7	5	4	1		Encourages self-reliance
5	11	2	7	5	4	10		Available anywhere 24x7
5	11	2	7	5	4	10	1	Fits distance learning
5	11	2	7	5	4	11		Improves access for some students
5	11	2	7	5	4	11	7	Flexible student access
5	11	2	7	5	4	11	8	Levels playing field for EFL student
5	11	2	7	5	4	11	10	Cope with diverse student abilities
5	11	2	7	5	4	24		Improves student performance
5	11	2	7	5	4	24	1	Monitor usage & grasp
5	11	2	7	5	4	24	2	Non-threatening private feedback
5	11	2	7	5	4	24	3	Reduce stress
5	11	2	7	5	4	24	4	Better-prepared students
5	11	2	7	5	4	24	5	Encourage student to work throughout
5	11	2	7	5	4	24	6	Remedial drills

5	11	2	7	5	6	17	Compatible with team teaching
5	11	2	7	5	6	27	Complements tutor involvement
5	11	2	7	5	7		Flexibility
5	11	2	7	5	8		Rapid feedback to all
5	11	2	7	5	9		Facilitates diagnostic testing
5	11	2	7	5	10		Benefits for institutions
5	11	2	7	5	10	1	Forces re-evaluation of practice
5	11	2	7	5	10	4	Keeps tutors engaged
5	11	2	7	5	11		Increased reliability
5	11	2	7	5	12		Benchmarking
5	11	2	7	5	13		Fosters online communities
5	11	2	7	5	16		Standards are clear and transparent
5	11	2	7	5	22		Assess entire curriculum
5	11	2	7	5	22	26	Infinite numbers of questions
5	11	2	7	5	25		Diagnostic testing
5	11	2	7	5	38		Exposes students to new ass modes
5	11	2	7	5	38	34	New question types
5	11	2	7	5	54		Reduces cheating
5	11	6					Realistic expectations
5	11	6	1				Well-defined L&T project
5	11	6	2				Time savings are hard-won
5	11	6	3				Aware of alternatives
5	11	6	4				good materials time-consuming
5	11	6	5				More than a time-saver
5	12						**Obstacles- tutors attitudes**
5	12	2					CAA threatens tutors independence
5	12	3					Feel unsupported by institution
5	12	3	1				Perceived tension L&T vs RAE
5	12	4					Low confidence in CAA
5	12	4	1				Few ~real~ benefits for students~
5	12	4	2				Difficult to tailor feedback
5	12	4	3				Once bitten twice shy
5	12	4	4				Bad news has winged feet
5	12	4	7				Summative fears
5	12	4	7	4			Concerns- cheating
5	12	4	7	4	1		Authentication issues
5	12	4	7	4	117		Difficult to invigilate summative tests
5	12	4	7	6			Concerns- poor reliability
5	12	4	7	24			Concerns- fairness
5	12	4	7	24	1		Inaccessibility of MM elements
5	12	4	7	24	2		Inflexible tests penalise disabled s
5	12	4	7	24	3		Non-ICT competent students disadvantage
5	12	4	7	24	5		Test mode effects
5	12	4	7	24	7		Some students disadvantaged
5	12	4	7	50			Plagiarism fear- so formative

5	11	2	7	5	4	24	7	Rapid ID of vulnerable students	
5	11	2	7	5	4	24	12	some students do well at it	
5	11	2	7	5	4	24	16	Facilitates self-paced study	
5	11	2	7	5	4	24	19	Keeps students motivated	
5	11	2	7	5	4	24	20	Revision	
5	11	2	7	5	4	24	39	Allows tests tailored to needs	
5	11	2	7	5	4	24	60	Improved formative feedback to students	
5	11	2	7	5	4	24	60	1	Objective prompt AutoMark feedback
5	11	2	7	5	4	24	60	2	Rich feedback down to tutor
5	11	2	7	5	4	24	60	11	rapid feedback to students
5	11	2	7	5	4	24	60	12	Frequent testing
5	11	2	7	5	4	24	60	20	Students can use them as formative a
5	11	2	7	5	4	24	60	59	formative use
5	11	2	7	5	5	More frequent assessment			
5	11	2	7	5	5	19	Re-testing of students~		
5	11	2	7	5	6	Benefits for tutors			
5	11	2	7	5	6	1	Replace onerous coursework		
5	11	2	7	5	6	2	Strengthens tutors independence		
5	11	2	7	5	6	3	Good for career		
5	11	2	7	5	6	4	Relieve academics of coding burden		
5	11	2	7	5	6	5	Relieve academics of admin burden		
5	11	2	7	5	6	6	Saves time in classroom		
5	11	2	7	5	6	7	Test all year groups		
5	11	2	7	5	6	8	Potential productivity gains		
5	11	2	7	5	6	9	Tutors assess teaching effectiveness		

5	12	4	31	Concerns- ped fitness for purpose			
5	12	4	31	1	Feedback limited by tutor effort		
5	12	4	31	2	Fears of external examiner		
5	12	4	31	3	Inflexible tools		
5	12	4	31	4	Time to ascertain cost effectiveness		
5	12	4	31	5	Pressure to use CAA inappropriately		
5	12	4	31	6	Difficulty of testing HLOs		
5	12	4	31	6	8	Facilitates surface ass approaches	
5	12	4	31	6	8	9	Facilitates mech. approach
5	12	4	31	6	8	10	Promotes learning-to-the-test
5	12	4	31	6	11		Intrinsic weakness of Objective item
5	12	4	31	6	11	2	Thinking of good questions
5	12	4	31	6	11	3	Difficult to explore deep learning
5	12	4	31	6	11	4	Difficult to assess underlying skill
5	12	4	31	6	11	5	MCQ has ped limits, others are hard
5	12	4	31	6	11	6	The need for a 'right answer'
5	12	4	31	6	11	7	ambiguities in question wording
5	12	4	31	6	11	8	Can't test analysis
5	12	4	31	6	11	9	Can't test critical evaluation
5	12	4	31	6	11	10	Can't test understanding
5	12	4	31	6	11	12	Can't replace essays
5	12	4	31	6	11	15	Objective items dont suit all subjec
5	12	4	31	6	11	16	Can't show problem-solving
5	12	4	31	6	11	18	easy to author poor items
5	12	4	31	6	11	22	Difficult item design
5	12	4	31	8	Lower levels, not final years		
5	12	4	31	9	QA fears- commercial QBs		
5	12	4	31	10	most relevant to large cohorts		
5	12	4	31	13	Widespread perception its just MCQs		
5	12	4	31	14	Poor correlation CAA & CW		
5	12	4	31	15	Unsuitable for some subjects		
5	12	4	31	15	1	Doesn’t suit some LOs	
5	12	4	31	20	CAA requires triangulation		
5	12	6	Unrealistic expectations				
5	12	6	2	Timesaving attitude- poor use			
5	12	6	3	Expect 'free lunch'			

6. Tutors' attributes

6	13				**Drivers- Tutors' attributes**
6	13	1			Informed attitudes to assessment
6	13	1	1		CAA enriched by some tutor-marking
6	13	1	2		Recognise potential of CAA
6	13	1	2	24	Good understanding of CAA issues
6	13	1	2	36	Grasp that CAA is more than MCQs
6	13	1	3		Know why they're doing it
6	13	1	4		Understand objective item use
6	13	1	5		Prepared to commit time upfront
6	13	1	6		Phased approach to implementation
6	13	1	7		Liaison with students
6	13	1	11		Tutors make mixed difficulty tests
6	13	1	20		Academics familiarity with processes
6	13	9			Tutors have required skills
6	13	9	22		Required CAA skills possessed
6	13	9	22	8	CAA requires a range of expertise
6	13	9	22	13	Possess good item-writing skills
6	13	9	32		ICT awareness & competence
6	13	9	32	44	users are web-skilled
6	13	10			Enthusiasts
6	13	10	1		Adaptability
6	13	10	2		Choose to invest time in new tools
6	13	10	2	1	Its fun
6	13	10	2	3	Willing to innovate
6	13	10	2	5	Commitment
6	13	10	17		Volunteers & Champions
6	13	12			Good experience of CAA
6	13	12	2		Grew up with CAA
6	13	12	3		Acceptance that it works
6	13	12	7		it works first time!
6	13	12	18		Compiling CAA test more fun than marking

6	14					**Obstacles- Tutors' attributes**
6	14	2				Skills shortfalls
6	14	2	1			Gaps in IT skills
6	14	2	2			Underestimate time required
6	14	2	3			Lack of experience
6	14	2	11			Gaps in pedagogical skills
6	14	2	11	1		Uninformed attitude to assessment
6	14	2	11	4		Inability to write good questions!
6	14	2	11	4	2	Specialised skills required
6	14	2	11	7		Ignorance of CAA applications
6	14	2	11	9		Requires new skills
6	14	2	11	12		Students couldn't practice 1st
6	14	9				Affective- Technophobia,Inertia
6	14	9	1			Resistance to change
6	14	9	2			Lack of commitment
6	14	9	3			General technophobia
6	14	9	3	8		Scared things will go wrong
6	14	9	3	10		Fear of the unknown
6	14	9	4			Apathy, narrow mindedness
6	14	9	5			Luddism
6	14	9	6			Unwillingness to commit resources
6	14	9	7			Ignorance of what CAA can do
6	14	9	8			Sceptical academics
6	14	9	9			Unwilling to make friends with tools
6	14	9	10			Effort to redesign what works
6	14	9	11			Choose to invest time other ways
6	14	9	52			uncomfortable about own ability
6	14	10				Conscripted tutors
6	14	10	1			CAA conscripts make poor use
6	14	10	2			It was more or less forced on us
6	14	10	10			lack of enthusiasm from staff
6	14	12				Poor experience of CAA

Appendix G: Denzin and Lincoln’s QR framework

1 **Traditional**	2 **Modernist**	3 **Blurred genres**	4 **Crises of represen-tation**	5 **Post-modern experimental**	6 **Post-experimental**	7 **Seventh moment**
1900 → Positivism and objectivity in ethno-graphers fieldwork and reports	1950 → Methodological rigor and procedural formalism. Challenges to Positivism (Symbolic Interactionism)	1970 → Many alternative approaches emerged: creating competition and confusion (e.g. hermeneutics, structuralism, phenomenolog y, feminism). Borrow from many different disciplines	1986 → Production of Reflective Texts: reflexivity, power, privilege, race, gender, class all undermining traditional notions of validity and neutrality	1990 → triple crisis of representation, legitimation and praxis creative and interpretive nature of writing; perspectives of writer; evaluation and quality refusal to privilege any method or theory activist (democratic racial justice) / political and participatory approaches	1995 → boundaries expanded to include creative non-fiction, autobiographical ethnography, poetic representations, multimedia presentations	2000 → researchers cease debating differences and celebrate the ‘marvellous variety’ of their creations

Appendix H: Wilson & Stacey's 2004 SD framework

Levels	**Description of staff at this level**	**Staff Development content and approach**
Level 1	Beginners, novice, lack of familiarity with online teaching, lack of experience with technology in teaching. Aware of innovation using technology in teaching, Varying levels of interest in technology amongst staff at this level, some are reluctant. Primary need is the identification of opportunities to use technology effectively	'Show and Tell' activities, operational training, short seminars on current activities within the institution, guest speakers and exemplars.
Level 2	Advanced beginner, limited exposure, required to use technology Some experience in teaching in flexible learning environments 'Learning the process'	Stage 1 activities plus instructional design skills, skills in online pedagogy, learning management system skills, skills in use of email, discussion boards, role play and debates to increase interactivity online. More reflection encouraged at this stage to consolidate staff theoretical knowledge; project-based learning.
Level 3	Want to try things out; want to use online learning environments, still may have limited skills and exposure to technology in teaching. Implementing the innovation in their work Exploring and experimenting Applying the process	Stage 1 and 2 skills plus focus on more complex technical knowledge, more complex forms of interactivity online (eg. collaborative group learning), preparing staff to handle problems of more intensive online discussions (eg. flaming, lack of responses); case studies are useful approach with this stage of development.
Level 4	Competent Advanced Proficient Expert Improving the innovation Consolidation of skills and learning	Staff at this stage become role models for others, act as resource for other staff, providing advice, engaged in research and development focussed activities, can be used as formal and informal participants in a staff development program.

Glossary

The following terms are used in this thesis and are defined here. They were not derived from the JISC-sponsored e-Assessment Glossary which was published after this glossary was prepared.

5th Discipline, The Peter Senge identified a missing element in contemporary theory of organisational change as the ability of individuals to work in teams across traditional organisational boundaries.

Axial coding According to Strauss and Corbin, the process of relating core categories to each other at the level of their subcategories.

Bloom's taxonomy A scheme of ordered levels representing progressively more abstract forms of knowledge ranging from basic declarative knowledge (easily-tested low level learning outcomes) to the most abstract skills (the difficult to test high-order learning outcomes)

Browser See 'Web browser'.

Browser-based assessment See on-line assessment.

CAA Computer-assisted assessment. According to Colleen McKenna and Joanna Bull (McKenna and Bull, 2000 p. 25), "the term 'Computer-assisted Assessment' (CAA) encompasses the use of computers to deliver, mark and analyse assignments or examinations. It also includes the collation and analysis of data gathered from optical mark readers (OMR)" (McKenna and Bull, 2000 p.25)

CAA Centre. A TLTP-3 funded initiative that was established to provide a UK centre of excellence in CAA practice.

CAL Computer-assisted learning.

CBA Computer-based assessment.

C&IT Communications and information technology. Term used in the Dearing Report to collectively identify a range of technologies including computers and networks. See ICT.

CTT Classical test theory. Used to assess the validity of items in terms of relative facility and how they discriminated between participants of different ability. Outcome depends on the sample used- item and candidate are linked.

Discrimination A measure of how item performance correlates to performance in the test as a whole.

Department The basic academic organisational unit in universities. Sometimes called a 'School'.

Diffusion shorthand for the diffusion of innovations (Rogers, 2003)

Distractor An incorrect objective item option. Several of these together provide credible alternatives to the *key* (i.e. the correct choice)

Drag-and-drop. A graphical objective item type that accepts a choice made on the basis of dragging a small marker graphic on to a designated target graphic.

e-Assessment Any assessment activity delivered by electronic means. Includes *CAA*, *CBA* and *online assessment*.

Early majority In classical diffusion theory the 33% of people who adopt an innovation just before the mean adoption time.

Enthusiasts In classical diffusion theory the 13.5% who follow innovators and adopt an innovation before the early majority

Essay item An item that can accepts a large amount of free-form text. Usually a container for essay-style answers that can be marked by a human examiner, although the possibility of automated marking exists

Facility A measure of item difficulty- divide the mean mark by the maximum mark.

Faculty In the UK, an organisational grouping in an educational institution. In the US, a generic name for academic teachers.

Fill-in-blank ('FIB') An objective item type that accepts a short written (usually typed) answer.

Freeze model Kurt Lewin's (1951) characterisation of organisational change as an equilibrium established between conservative and progressive forces which left to itself will revert to established practices unless shaken up ('melted') and then frozen in a new configuration.

Grounded Theory (GT) A qualitative data analysis methodology in which theory is grounded in and emerges directly from data using a 'constant comparative' iterative approach. See Glaser and Strauss (1967) for the original account.

GT see *Grounded Theory.*

HE Higher education. In the UK, this is formal post-18 undergraduate or graduate education which culminates in the award of a degree or diploma when successfully completed. It normally takes places within, or associated with, a university or other HEI.

HEA Higher Education Academy. Took on the responsibilities and function of the ILT in 2004.

HEI Higher education institution. Usually understood to mean a university, but includes other bodies with degree-awarding powers such as colleges of higher education and medical schools.

HLOs Higher-order learning outcome. The analytical and synthetic elements of *Bloom's taxonomy*.

ICT Information and communications technology. See ICT.

ILT (ILTHE) Institute for Learning and Teaching in Higher Education. A body formally recognised in the Dearing Report which was charged with the responsibility of fostering professional learning and teaching skills in HE teachers. Now subsumed by the Higher Education Academy (HEA).

Internet A globe-spanning 'network of networks'.

Intranet An internal network that supports browser-based access to web-based services

Innovators In classical diffusion theory the 2.5% people who populate the first and earliest segment of the uptake curve.

Interoperability The ability to exchange data seamlessly between enterprise systems.

IRT (IRT1, IRT2, IRT3) Item response theory. A form of item analysis that has three variants- IRT1, IRT2 and IRT3 according to the number of variable considered. For example, IRT3 considers the three variables *difficulty, discrimination* and *chance*.

Item Technical term for an objective test question.

JCALT JISC Committee for Awareness, Liaison and Training.

JISC Joint Information Service Committee. Central funding body for ITC in UK further and higher education.

Key The correct option in an *objective item*.

Laggards In classical diffusion theory, the remaining 16.5% of people who adopt an innovation after the late majority.

Late majority In classical diffusion theory, the 33% of people who adopt an innovation just after the mean time to adopt.

Learning Technologist (LT) A professional with both pedagogic and technical skills generally employed to support academic teachers in applying technology to learning and teaching.

LLOs Lower-order learning outcomes. The declarative knowledge elements of *Bloom's taxonomy.*

LMS Learning management system. Another term for a *VLE*.

LT Learning technology.

Matching item An objective item type that accepts choices in the form of matching a set of stimuli with possible responses.

Network In the context of this study, a network is understood to be a communications infrastructure that connects a set of computers.

MCQ Multiple-choice question. An objective item type that accepts one selection from a set of mutually exclusive options.

MLE Managed learning environment.

Moore's Gap An apparent hiatus in the technology uptake curve between the enthusiasts and the early majority.

MRQ Multiple-response question. An objective item type that accepts one or more selections from a set of options.

New University a UK HEI that received its degree-awarding charter after 1992 (see Old university)

Objective item A question comprised of a *stem* (a stimulus requesting a responses in the form of a choice or set of choices) and a set of options that includes a *key* (the correct responses) and one or more distractors (incorrect responses provided as decoys).

Objective test A test composed of a collection of objective items

OFFSTED Office for standards in education. UK government agency charged with responsibility for quality assurance of school-age education in England and Wales.

Old university a UK HEI that received its degree-awarding charter before 1992 (see New university).

OMR Optical mark reader.

Online Assessment Participants use a *web browser* to take assessments that are hosted on a *web server*. The network connection may be a closed network, an institutional *intranet* or the *internet*.

On-screen assessment See *computer-based assessment* (CBA).

Open coding According to Strauss and Corbin, the process of fracturing data into the smallest units of meaning.

Paradigm, The One of the analytical devices in Strauss and Corbin's grounded theory analysis toolkit.

Perception™ a dedicated *CAA* system sold and supported by Questionmark Computing Limited

Pencil-and-paper Traditional medium of assessment where participants write answers to examination questions on paper.

Plagiarism The practice of using the ideas of others without acknowledging their origin.

PRAM See *Project Risk Analysis and Management.*

Project In the context of *project risk analysis and management*, a specific instance of work which has a clearly defined beginning and end and which entails innovation and consequent risk.

Project Risk Analysis and Management (PRAM) A discipline concerned with risk management within the context of a *project.*

QAA Quality Assurance Agency for Higher Education. UK government agency charged with responsibility for quality assurance of higher education in England and Wales.

Rasch analysis A type of formal item analysis that usually considers difficulty as a single variable. Resembles *IRT1*.

Response The submitted answer to an *objective item*.

Risk 'An uncertain event or set of circumstances that, should it occur, will have an effect on the achievement of the project's objectives' (APM, 1997 p. 16)

Risk analysis The assessment, management and communication of risk.

Risk efficiency In simple terms, a relative measure of the extent to which a good balance has been struck between a desirable outcome and the degree of risk taken to obtain it. A good description is given by Chapman and Ward (Chapman and Ward, 2003 pp. 37-38).

Risk mitigation actions taken to reduce the severity and impact of a risk.

Sequencing item An objective item type that accepts answers in the form of an ordered list.

Selective coding According to Strauss and Corbin, the process of selecting the single core category which has the greatest explanatory power and relating all the other categories to it. This is the point at which a grounded theory is said to emerge in Strauss and Corbin's prescription.

Stem The textual 'question' part of an item.

Technology uptake curve Roger's definition of the characteristic profile by which technological innovations diffuse through a society. First described by Gabriel Tarde in the 19^{th} century.

Theoretical coding A basic GT process for coding strands of an emergent theory.

Theoretical sampling A basic GT process for choosing samples for data collection in order to address perceived gaps in the emergent theory.

THES Times Higher Education Supplement.

TLTP Teaching and Learning Technology Partnership. UK body set up to fund and promote the use of learning technology in UK further and higher education.

TOIA A JISC-funded project to provide a web-based CAA tool that is free of charge for FE and HE users in the UK.

VLE Virtual learning environment. Provides a wide range of e-learning tools throughout an institution. Examples include Blackboard™ and Moodle.

Web browser ('browser') A client computer program that presents web pages from and may accept input to, a web server-based program using the internet (or an intranet).

Web server A computer that serves web pages to client browsers using the internet (or an intranet).

WBA Web-based assessment. See *online assessment*.

World-wide web ('the web', WWW) 'The 'web' originated in Tim (now 'Sir') Berners-Lee's work at CERN in the 1980's which aimed to make the internet easier to use. The first *browser* was a product of this work. *Server-side* applications that are available through the web are referred to as 'web-based'.

References cited in text of this thesis

ALT (2003) *The Future of Higher Education: The Association for Learning Technology's response to the White Paper*. [online] available: www.alt.ac.uk/docs/he_wp_20030429_final.doc [last accessed 1-8-03]

ANDERSON, L., KRATHWOHL, D. & BLOOM, B. (2001) *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* New York: Longman

ANDERSON, T., VARNHAGEN, S. & CAMPBELL, K. (1998) Faculty adoption of teaching and learning technologies: Contrasting earlier adopters and mainstream faculty. *The Canadian Journal of Higher Education*, vol. 28, no. (2), pp. 71-98.

ANGLIN, G. (1995) *Instructional technology: past, present, and future* 2nd edn. Englewood, Colorado: Libraries Unlimited

APM (1997) *PRAM Project Risk Analysis and Management Guide* Norfolk, UK: Association for Project Management

ATKINSON, P., COFFEY, A., DELAMONT, S., LOFLAND, J. & LOFLAND, L. (eds) (2001) *Handbook of ethnography*, Sage, London.

AXELSSON, K. & GOLDKUHL, G. (2004) Theory Modelling- Action Focus when Building a Multi-Grounded Theory. IN: *3rd European Conference on Research Methods in Business and Management*. Reading, University of Reading, 29th-30th April 2004.

BACSICH, P. (2005a) *Benchmarking e-Learning: An Overview for UK HE*. [online] available: http://www.alt.ac.uk/altc2005/timetable/files/527/Benchmark_overview.doc [last accessed 3-12-05]

BACSICH, P. (2005b) *Theory of Benchmarking for e-Learning: A Top-Level Literature Review by Paul Bacsich*. [online] available: http://www.cs.mdx.ac.uk/news/Benchmark-theory.pdf [last accessed 16-12-05]

BARLOW, J. & MÖLLER, C. (1996) *A Complaint is a Gift* San Francisco CA: Berrett-Koeler

BARNETT, R. (1997) *Higher education: a critical business* Buckingham: Open University Press & Society for Research into Higher Education

BBC (2005) *BBC investigation into university standards*. [online] available: http://www.bbc.co.uk/print/pressoffice/pressreleases/stories/2005/10_october/31/university.shtml [last accessed 1-11-05]

BBC NEWS (2003) *Ministers accused of 'dumbing down' unis*. [online] available: http://news.bbc.co.uk/1/hi/education/2960730.stm [last accessed 6-2-05]

BBC NEWS (2004a) *Degree grades 'show dumbing down'* [online] available: http://news.bbc.co.uk/1/hi/education/3515984.stm [last accessed 05-02-05]

BBC NEWS (2004b) *Testing Times for Education*. [online] available: http://news.bbc.co.uk/1/hi/education/4026891.stm [last accessed 20-11-04]

BECK, U. (1992) *Risk Society: Towards a New Modernity* trans. M., R. London: Sage

BEETHAM, H. (2001) *Learning technology: institutional audit tools: Notes to JCALT for distribution to all UK HEIs*. [online] available: http://www.eres.ac.uk/source/docs/pub-ou-35.pdf [last accessed 30-12-02]

BEETHAM, H. (2005) *JISC Pedagogies for e-Learning Programme: Initial Review*. [online] available: http://www.jisc.ac.uk/uploaded_documents/Review%20models.doc [last accessed 28-12-05]

BEETHAM, H., JONES, S. & GORNALL, L. (2001) *Career Development of Learning Technology Staff: Scoping Study Final Report, JISC Committee for Awareness, Liaison and Training Programme*. [online] available: http://sh.plym.ac.uk/eds/effects/jcalt-project/ [last accessed 19-3-04]

BENNETT, R. (2002a) Inexorable and Inevitable: The Continuing Story of Technology and Assessment. *Journal of Technology, Learning, and Assessment*, vol. 1, no. (1), pp. 3-23.

BENNETT, R. (2002b) *Using Electronic Assessment to Measure Student Performance*. [online] available: http://www.nasbe.org/Standard/10_Summer2002/bennett.pdf [last accessed 17-7-04]

BERA (2004) *Revised Ethical Guidelines for Educational Research*, BERA, Southwell.

BERNSTEIN, P. L. (1996) *Against the Gods: A Remarkable Story of Risk* New York: John Wiley

BERTALANFFY (1968) *General system theory foundations, development, applications* Rev. edn. New York: Braziller

BEST, H. (2002) Evaluating the introduction of CBA into the learning, teaching and assessment of the diagnostic radiography course at Sheffield Hallam University. IN: DANSON, M., ed., *Proceedings of 6th International CAA Conference*. Loughborough, University of Loughborough.

BIGGS, J. (1999) *Teaching for Quality Learning at University* Buckingham: Open University Press / Society for Research into Higher Education

BLOOM, B., ENGELHART, M., FURST, E., HILL, W. & KRATHWOHL, D. (1956) *Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook 1: Cognitive Domain* London: Longman

BOCOCK, J. & WATSON, D. (eds) (1994) *Managing the University Curriculum: Making Common Cause*, Open University Press / Society for Research into Higher Education, Buckingham.

BOYLE, A., HUTCHISON, D., O'HARE, D. & PATTERSON, A. (2002) Item Selection and Application in Higher Education. IN: DANSON, M., ed., *Proceedings of 6th International CAA Conference*. Loughborough, University of Loughborough.

BOYLE, A. & O'HARE, D. (2003) Assuring quality Computer-Based Assessment development in UK Higher Education. IN: CHRISTIE, J., ed., *Proceedings of 7th International CAA Conference*. Loughborough, University of Loughborough.

BROWN, G., BULL, J. & PENDLEBURY, M. (1997) *Assessing Student Learning in Higher Education* London: Routledge.

BRYMAN, A. & CRAMER, D. (1997) *Quantitative Data Analysis with SPSS for Windows* London: Routledge.

BSI (2002) *Code of practice for the use of information technology (IT) in the delivery of assessments* London: BSI

BULL, J. (1999) Update on the National TLTP3 Project 'The Implementation and Evaluation of Computer-assisted Assessment'. IN: DANSON, M., ed., *Proceedings of 3rd International CAA Conference*. Loughborough, University of Loughborough.

BULL, J. (2001) *TLTP85 Implementation and Evaluation of Computer-assisted Assessment: Final Report*. [online] available: http://www.caacentre.ac.uk/dldocs/final_report.pdf [last accessed 16-3-03]

BULL, J., CONOLE, G., DAVIS, H., WHITE, S., DANSON, M. & SCLATER, N. (2002) *Rethinking Assessment Through Learning Technologies*. [online] available: http://www.ascilite.org.au/conferences/auckland02/proceedings/papers/056.pdf [last accessed 17-3-03]

BULL, J. & HESKETH, I. (2001) Computer-Assisted Assessment Centre Update. IN: DANSON, M., ed., *Proceedings of 5th International CAA Conference*. Loughborough, University of Loughborough.

BULL, J. & MCKENNA, C. (2000) Computer-assisted Assessment Centre (TLTP3) Update. IN: DANSON, M., ed., *Proceedings of 4th International CAA Conference*. Loughborough, University of Loughborough.

BULL, J. & MCKENNA, C. (2002) *Blueprint for CAA* Loughborough: University of Loughborough

BULL, J. & MCKENNA, C. (2004) *Blueprint for Computer-assisted Assessment* London: RoutledgeFalmer

BULL, J., MCKENNA, C. & HESKETH, I. (1999) Computer-assisted Assessment (CAA) National Survey Questionnaire. CAA Centre, University of Luton.

BURNES, B. (2004) Kurt Lewin and the Planned Approach to Change: A Re-appraisal. *Journal of Management Studies,* vol. 41, no. (6), pp. 977-1002.

BURRELL, B. and MORGAN, G. (1979). Sociological paradigms and organisational analysis. Heinemann: United Kingdom

CARR, V. H. (1999) *Technology Adoption and Diffusion* [online] available: http://tlc.nlm.nih.gov/resources/publications/sourcebook/adoptiondiffusion.html [last accessed 7-12-03]

CHAPMAN, C. & WARD, S. (2003) *Project Risk Management* Chichester: John Wiley

CHARMAZ, C. (2000) Grounded Theory: Objectivist and Constructivist Methods. IN: DENZIN, N. & LINCOLN, Y. (eds), *Handbook of Qualitative Research*, 2nd edn, Sage, London, pp. 509-535.

CHARMAZ, C. & MITCHELL, R. (2001) Grounded Theory in Ethnography. IN: ATKINSON, P., COFFEY, A., DELAMONT, S., LOFLAND, J. & LOFLAND, L. (eds), *Handbook of Ethnography*, Sage, London, pp. 160-176.

CLEGG, K. (2005) *Playing safe: learning and teaching in undergraduate law*. [online] available: http://www.ukcle.ac.uk/research/ukcle/ncle.html [last accessed 8-11-05]

COHEN, L. & MANION, L. (1994) *Research Methods in Education* 4th edn. London: Routledge

CONOLE, G., CREW, E., OLIVER, M. & HARVEY, J. (2001) A toolkit for supporting evaluation. *ALT-J*, vol. 9, no. (1), pp. 38-49.

CONOLE, G. & DYKE, M. (2004) What are the affordances of information and communications technology? *ALT-J*, vol. 12, no. (2), pp. 113-124.

CONOLE, G. & OLIVER, M. (2002) *Embedding Theory into Learning Technology Practice with Toolkits*. [online] available: http://www-jime.open.ac.uk/2002/8/conole-oliver-02-8-paper.html [last accessed 10-12-05]

CONOLE, G. & WARBURTON, W. (2005) A review of computer-assisted assessment. *ALT-J*, vol. 13, no. (1), pp. 17-31.

COOKE, R. (2003) *Teaching Quality Enhancement Committee Final Report on the Future Needs and Support for Quality Enhancement of Learning and Teaching in Higher Education* [online] available: http://www.hefce.ac.uk/learning/tqec/final.htm [last accessed 20/12/05]

COOMBES, H. (2001) *Research using IT* Basingstoke: Palgrave

CORNFORD, J. (2005) *The Virtual University is (paradoxically) the University Made Concrete*. [online] available: http://virtualsociety.sbs.ox.ac.uk/pick/pick6.htm [last accessed 31-12-05]

COSEMANS, D., VAN RENTERGEM, L., VERBURGH, A. & WILS, A. (2002) A Campus Wide Setup of Question Mark Perception (V2.5) at the Katholieke Universiteit Leuven (Belgium) - Facing a Large Scale Implementation. IN: DANSON, M., ed., Proceedings of 6th *International CAA Conference*. Loughborough, University of. Loughborough

DAILY MAIL (2004) *Why can't I find a plumber?* 17-4-04 p.19

DAILY MAIL (2005) *Bold words from Mr Blair (again)*. [online] available: http://www.dailymail.co.uk/pages/live/articles/news/newscomment.html?in_article_id=369136&in_page_id=1787&expand=true [last accessed 14-12-05]

DANIELS, H. & COLE, T. (2002) The Development of Provision for Young People with Emotional and Behavioural Difficulties: an Activity Theory Analysis. *Oxford Review of Education*, vol. 28, no. (2), pp. 311-329.

DANSON, M., DAWSON, B. & BASELEY, T. (2001) Large Scale Implementation of Question Mark Perception (V2.5) – Experiences at Loughborough University. IN: DANSON, M., ed., *Proceedings of 6th International CAA Conference*. Loughborough, University of Loughborough.

DANSON, M., HILTON, A., DAWSON, B., BASELEY, T., BULLEN, N. & EASTON, C. (2003) *Implementing online assessment in an emerging MLE: a generic guidance document with practical examples*. [online] available: http://www.jisc.ac.uk/index.cfm?name=caa_finalreport [last accessed 12-12-05]

DARWIN, C. (1958) *On the Origin of Species by Means of Natural Selection, or, the Preservation of Favoured Races in the Struggle for Life* London: John Murray

DAVIES, P. (2001) CAA MUST be more than multiple-choice tests for it to be academically credible? IN: DANSON, M., ed., *Proceedings of 5th International CAA Conference*. Loughborough, University of Loughborough.

DAVIES, P. (2002) There's no confidence in multiple-choice testing. IN: DANSON, M., ed., *Proceedings of 6th International CAA Conference*. Loughborough, University of Loughborough.

DEARING, R. (1997) *Higher Education in the Learning Society*. [online] available: http://www.leeds.ac.uk/educol/ncihe/ [last accessed 21.04.03]

DEMPSTER, J. & DEEPWELL, F. (2002) *A review of successful project approaches to embedding innovation into institutional teaching and learning practices in higher education.* [online] available: http://www.warwick.ac.uk/ETS/TELRI/Publications/altbook.pdf [last accessed 26-4-03]

DENZIN, N. K. & LINCOLN, Y. S. (2000) *Handbook of qualitative research* 2nd edn. Thousand Oaks, Calif. ; London: Sage

DENZIN, N. K. & LINCOLN, Y. S. (2003) *The landscape of qualitative research : theories and issues* 2nd edn. Thousand Oaks, Calif. ; London: Sage Publications

DICK, R. (1993) *You want to do an action research thesis?* [online] available: http://www.uq.net.au/action_research/art/arthesis.html [last accessed 2.2.2003]

DICK, R. (1998) *Convergent interviewing: a technique for qualitative data collection*. [online] available: http://www.scu.edu.au/schools/gcm/ar/arp/iview.html [last accessed 9-11-05]

DREVER, E. (1995) *Using semi-structured interviews in small-scale research* Glasgow: Scottish Council for Research in Education

DUKE-WILLIAMS, E. & KING, T. (2001) Using Computer-aided Assessment to Test Higher Level Learning Outcomes. IN: DANSON, M., ed., *Proceedings of 5th International CAA Conference*. Loughborough, University of Loughborough.

ELTON, L. & JOHNSTON, B. (2002) *Assessment in Universities: a critical review of research*. [online] available: http://www.heacademy.ac.uk/resources.asp?process=full_record&section=generic&id=13 [last accessed 12-12-05]

EVARISTO, J. & KARAHANNA, E. (1998) The impact of Mental Workload in the Evaluation of Innovations. IN: LARSEN, T. & MCGUIRE, E. (eds), *Information Systems Innovation and Diffusion: Issues and Directions*, Idea Group Publishing, London.

FARTHING, D. & MCPHEE, D. (1999) Multiple choice for honours-level students? IN: DANSON, M., ed., *Proceedings of 3rd International CAA Conference*. Loughborough, University of Loughborough.

FULKERTH, R. (2005) *A Bridge for Distance Education: Planning for the Information-Age Student*. [online] available: http://www2.warwick.ac.uk/services/cap/resources/interactions/archive/issue8/fulkerth/ [last accessed 12/12/05]

FULLICK, P. L. (2004) *Knowledge Building Among School Students Working in a Networked Computer Supported Learning Environment*. Unpublished PhD Thesis, University of Southampton.

GARDNER-MEDWIN, A. & GAHAN, M. (2003) Formative and Summative Confidence-Based Assessment. IN: CHRISTIE, J., ed., *Proceedings of 7th International CAA Conference*. Loughborough, University of Loughborough.

GEOGHEGAN, W. (1994) *Whatever happened to instructional technology?* [online] available: http://eprints.ecs.soton.ac.uk/10144/01/ [last accessed 7-12-05]

GEOGHEGAN, W. (1995) Stuck at the barricades: Can information technology really enter the mainstream of teaching and learning? *Change*, vol. 27, no. (2), pp. 22-30.

GIBBS, G., HABESHAW, T. & YORKE, M. (2000) Institutional learning and teaching strategies in English higher education. *Higher Education*, no. (40), pp. 351-372.

GLASER, B. (1992) *Basics of Grounded Theory Analysis: Emergence vs. Forcing* Mill Valley, CA: Sociology Press

GLASER, B. (2002) *Constructivist Grounded Theory?* [online] available: http://www.qualitative-research.net/fqs/fqs-eng.htm [last accessed 31-07-05]

GLASER, B. (2005) *The Grounded Theory Perspective III: Theoretical Coding* Mill Valley, Ca.: Sociology Press

GLASER, B. G. & STRAUSS, A. L. (1967) *The discovery of grounded theory : strategies for qualitative research* London: Weidenfeld and Nicolson

GOODSON, I. (1993) *School Subjects and Curriculum Change* London: Routledge

GREENHALGH, T., ROBERT, G., BATE, P., KYRIAKIDOU, O., MACFARLANE, F. & PEACOCK, R. (2004) *How to Spread Good Ideas: A systematic review of the literature on diffusion, dissemination and sustainability of innovations in health service delivery and organisation*, University College London, London.

HAKKARAINEN, K. (1998) *Epistemology of Scientific Enquiry and Computer Supported Collaborative Learning*, Unpublished PhD thesis, University of Toronto.

HALPIN (1998) Editorial: Getting by through failing to deliver simple truths. *British Journal of Educational Studies*, vol. 46, no. (1), pp. 1-7)

HAMBRICK, K. A. (2002) *Critical Issues in Online, Large-scale Assessment: An Exploratory Study to Identify and Refine the Issues*, Unpublished PhD thesis, Capella University.

HAMMERSLEY, M. (1997) Educational research and teaching: a response to David Hargreaves' TTA lecture. *British Educational Research Journal*, vol. 23, no. (2), pp. 141-161.

HANSON, J. (2004) *Exploring Social Networks to Understand the Diffusion of Networked Learning in a Campus-Based University*. [online] available: http://www.shef.ac.uk/nlc2004/Proceedings/Individual_Papers/Hanson.htm [last accessed 1-1-05]

HARE, C. & WATERSTON, K. (2003) *Managing Student Assessment Records: Final Report*. [online] available: www.jisc.ac.uk/uploaded_documents/JISC%20-%20Final%20reportTheme%201a%20Student%20Assessment%20Records.doc [last accessed 1/12/05]

HARGREAVES, D. (1996) *Teaching as a research-based profession: possibilities and prospects*, TTA, London.

HART, C. (1998) *Doing a literature review: Releasing the Social Science research imagination* London: Sage

HARWOOD, I. (2002) *Developing Scenarios for Post-Merger and Acquisition Integration: A Grounded Theory of Risk Bartering*, Unpublished PhD thesis, University of Southampton.

HARWOOD, I. (2003) *Personal communication*.

HARWOOD, I. (2005a) What happens when Computer-assisted Assessment goes Wrong? *British Journal of Educational Technology* vol. 36, no. (4), pp. 587-597.

HARWOOD, I. & WARBURTON, W. (2004) Thinking the Unthinkable: Using Project Risk Management when Introducing Computer-assisted Assessments. IN: DANSON, M., ed., *Proceedings of 8th International CAA Conference*. Loughborough, University of Loughborough.

HEDEGAARD, M., CHAIKLIN, S. & JENSEN, U. (1999) Activity Theory and Social Practice: an Introduction. IN: CHAIKLIN, S., HEDEGAARD, M. & JENSEN, U. (eds), *Activity Theory and Social Practice*, Cambridge University Press, Cambridge.

HERD, G. & CLARK, G. (2003) *Computer-aided Assessment- Final Report and Guidelines for Implementation: Implementing CAA in the FE Sector in Scotland*. [online] available: http://www.onlineassessment.org/Glenrothes%20Report-final.pdf [last accessed 24.8.03]

HERO (2005) *UK HE Groups and Organisations*. [online] available: http://www.hero.ac.uk/uk/reference_and_subject_resources/groups_and_organisations1243.cfm [last accessed 1/12/2005]

HESA (2004) *Student Tables*. [online] available: http://www.hesa.ac.uk/holisdocs/pubinfo/stud.htm [last accessed 5-12-2004]

HILL, C., CUMMINGS, M. & VAN ALST, J. (2003) *Activity Theory as a Framework for Analyzing Participation within a knowledge Building Community*. [online] available: http://www.educ.sfu.ca/kb/Hill_Cummings.pdf [last accessed 12-6-04]

HOPKINS, D. (2002) *A teacher's guide to classroom research* 3rd edn. Buckingham: Open University Press

HOWARD, J. (1999) The role and development needs of general practice tutors. *Medical Teacher*, vol. 21, no. (6).

HUSSEY, J. & HUSSEY, R. (1997) *Business Research. A practical guide for undergraduate and postgraduate students* London: Macmillan Business

HYMAN, D., SHINGLER, J. & MILLER, M. (1992) Consumer Complaints and Public Policy: Validating the "Tip-of-the-Iceberg" Theory. *Sociological Practice*, vol. 10, pp. 97-122.

IMRIE, B. (1995) Assessment for Learning: Quality and taxonomies. *Assessment & Evaluation in Higher Education*, vol. 20, pp. 171-189.

IMS (2003) *(QTI) Enterprise v1.1 Specs, Examples and Schemas*. [online] available: http://www.imsglobal.org/specificationdownload.cfm [last accessed 2-3-03]

IOD (2001) *Higher Education: Institute of Directors Education Comment*. [online] available: http://www.iod.com/intershoproot/eCS/Store/en/pdfs/highereducation.pdf [last accessed 12/12/05]

JANESICK, V. (2000) The Choreography of Qualitative Research Design. IN: DENZIN, N. & LINCOLN, Y. (eds), *Handbook of Qualitative Research*, 2nd edn, Sage, Thousand Oaks, CA, pp. 379-399.

JEFFERIES, P. & WATERHOUSE, P. (2003) *Campus based managed learning environments: some of the issues*. [online] available: http://www.techinfonet.ac.uk/Resources/external-resources/PJ_ILT_PAPER1.doc/view [last accessed 12/1205]

JENKINS, M., BROWNE, T. & WALKER, R. (2005) *VLE Surveys: A longitudinal perspective between March 2001, March 2003 and March 2005 for higher education in the United Kingdom*. [online] available: http://www.elearning.ac.uk/news_folder/vlesurvey [last accessed 20/12/05]

JISC (2003a) *Circular 1/03: Managed Learning Environments for Lifelong Learning: Phase 2*. [online] available: http://www.jisc.ac.uk/index.cfm?name=circular_1_03 [last accessed 12/12/05]

JISC (2003b) *Introducing Managed Learning Environments (MLEs)*. [online] available: http://www.jisc.ac.uk/index.cfm?name=mle_overview [last accessed 16-3-03]

JONES, A., BARNARD, J., CALDER, J., SCANLON, E. & THOMPSON, J. (2000) Evaluating learning and teaching technologies in further education. *ALT-J*, vol. 8, no. (3), pp. 56-66.

KELSEY, K. (2003) *Grounded Theory Designs*. [online] available: http://www.okstate.edu/ag/agedcm4h/academic/aged5980/power/598314.ppt [last accessed 31-8-04]

KRATHWOHL, BLOOM & MASIA (1964) *Taxonomy of educational objectives the classification of educational goals* London: Longman

LAURILLARD (2002) *Rethinking university teaching a conversational framework for the effective use of learning technologies* 2nd edn. London: RoutledgeFalmer

LAY, S. & SCLATER, N. (2001) Question and Test Interoperability: An Update on National and International Developments. IN: SCLATER, N., ed., *Proceedings of 5th International CAA Conference*. Loughborough, University of Loughborough.

LEA, R. (2002) *Education and training: a business blueprint for reform: IoD Policy Paper*. [online] available: http://www.iod.com/intershoproot/eCS/Store/en/pdfs/edu1_4.pdf [last accessed 12/12/05]

LEE, S. (2005) *Higher Education Policy & Institutional Diversity under Labour 1997-2010*. [online] available: http://www.lmu.ac.uk/vco/reflect/jun05/cpse.pdf [last accessed 15/12/05]

LEWIN, K. (1944) Constructs in Field Theory. IN: CARTWRIGHT, D. (ed.), *Field theory in social science; selected theoretical papers*, New York: Harper & Row,.

LEWIN, K. (1947). 'Frontiers in group dynamics'. In Cartwright, D. (Ed.), *Field Theory in Social Science*, London: Social Science Paperbacks.

LEWIN, K. (1958). Group Decisions and Social Change. In *Readings in Social Psychology.* Swanson, G. E., Newcomb, T. M. and Hartley, E. L. (Eds.) New York: Holt, Rhinehart and Winston.

LILLEY, M. & BARKER, T. (2003) An Evaluation of a Computer Adaptive Test in a UK University Context. IN: CHRISTIE, J., ed., *Proceedings of 7th International CAA Conference*. Loughborough, University of Loughborough.

LINN, M. (1998) *Using Assessment to Improve Learning Outcomes: Experiences from the Knowledge Integration Environment (KIE) and the Computer as Learning Partner (CLP)*. [online] available: http://kie.berkeley.edu/KIE/info/publications/AERA98/assessment.html [last accessed 22/12/05]

LOMAS, L. & TOMLINSON, K. (2000) Standards: the varying perceptions of senior staff in higher education institutions. *Quality Assurance in Education*, vol. 8, no. (3).

MAGEE, B. (1982) *Popper* 3rd edn. London: Fontana

MASON, J. (2002) *Qualitative Researching* 2nd edn. London: Sage

MASON, O. & GROVE-STEPHENSEN, I. (2002) Automated free text marking with Paperless School. IN: DANSON, M., ed., *Proceedings of 6th International CAA Conference*. Loughborough, University of Loughborough.

MAUGHAN and MACKENZIE, (2004) *BioScope: The Assessment of Process and Outcomes using the TRIADSystem*. [online] available: http://www.cie.org.uk/CIE/WebSite/Data/PressRelease/Computer-based%20Assessments%20Change%20Face%20of%20Exams.pdf [last accessed 15/12/05]

MCALPINE, M. (2002a) *Design Requirements of a Databank* Luton: CAA Centre

MCALPINE, M. (2002b) *Principles of Assessment* Luton: CAA Centre

MCALPINE, M. (2002c) *A Summary of Methods of Item Analysis* Luton: CAA Centre

MCALPINE, M. & HESKETH, I. (2003) Multiple Response Questions- Allowing for Chance in Authentic Assessments. IN: CHRISTIE, J., ed., *Proceedings of 7th International CAA Conference*. Loughborough, University of Loughborough.

MCATEER, E. & MARSDEN, S. (2004) Frameworks for the Representation and Analysis of Networked Learning Activity. IN: *Networked Learning Conference 2004*. Lancaster, University of Lancaster Management School.

MCDONALD, A. S. (2002) The impact of individual differences on the equivalence of computer-based and paper-and-pencil educational assessments. *Computers & Education*, vol. 39, no. (3), pp. 299-312.

MCKENNA, C. & BULL, J. (2000) Quality assurance of Computer-assisted assessment: practical and strategic issues. *Quality Assurance in Education*, vol. 8, no. (1), pp. 24-31.

MCKENZIE, D., HALLAM, B., BAGGOTT, G. & POTTS, J. (2002) TRIADS experiences and Developments. IN: DANSON, M., ed., *Proceedings of 6th International CAA Conference*. Loughborough, University of Loughborough.

MCNAY, I. (1995) From the collegial academy to corporate enterprise: the changing cultures of universities IN: SCHULLER, T. (ed.), *The Changing University?*, Open University Press, Buckingham.

MILES, M. & HUBERMAN, A. (1994) *Qualitative data analysis: an extended sourcebook* Thousand Oaks: Sage

MILLER, A., IMRIE, B. & COX, K. (1998) *Student Assessment in Higher Education: A handbook for Assessing Performance* London: Kogan Page

MILLS, C., POTENZA, M., FREMER, J. & WARD, C. (2002) *Computer-based testing-building the foundation for future assessment* New Jersey: Laurence Erlbaum Associates

MOORE, G. A. (1999) *Crossing the chasm* Second edn. Oxford, Eng.: Capstone Publishing

NICHE (1997) *Higher Education in the Learning Society*. [online] available: http://www.leeds.ac.uk/educol/ncihe/ [last accessed 21.04.03]

O'REILLY, M. & MORGAN, C. (1999) Online assessment: creating communities and opportunities. IN: BROWN, S., RACE, P. & BULL, J. (eds), *Computer-assisted Assessment in Higher Education*, Kogan Page, London, pp. 149-161.

OED (2004) *Oxford English Dictionary Online*. [online] available: http://dictionary.oed.com/entrance.dtl [last accessed 13.11.04]

OLIVER, M. (2002) What do Learning Technologists do? *Innovations in Education and Teaching International*, vol. 39, no. (4), pp. 245-252.

OLIVER, M. & CONOLE, G. (2000) Assessing and enhancing quality using toolkits. *Journal of Quality Assurance in Education*, vol. 8, no. (1), pp. 32-37.

OLIVER, M., MACBEAN, J., CONOLE, G. & HARVEY, J. (2002) Using a Toolkit to Support the Evaluation of Learning. *Journal of Computer Assisted Learning*, vol. 18, no. (2), pp. 199-208.

OPPENHEIM, A. N. (1992) *Questionnaire Design, Interviewing and Attitude* London: Pinter

PAIN, D. & LEHERON, K. (2003) WebCT and Online Assessment: The best thing since SOAP? *Educational Technology & Society*, vol. 6, no. (2), pp. 62-71.

PEAT, M. & FRANKLIN, S. (2002) Use of Online and Offline Formative and Summative Assessment Opportunities: Have they had any Impact on Student Learning? IN: *ASCILITE 2002*. UNITEC, Auckland, NZ, UNITEC.

PERRY, C. & JENSEN, O. (2001) Approaches to combining induction and deduction in one research study. IN MURPHY, B. & EAGLE, L. (Eds.) *Australian and New Zealand Marketing Academy 2001 Conference* Massey University, Auckland, Australian and New Zealand Marketing Academy.

PHILLIPS & PUGH (1994) *How to get a PhD a handbook for students and their supervisors* 2nd edn. Buckingham: Open University Press

PHILO, G. & MILLER, D. (2000) *Cultural Compliance and Critical Media Studies*. [online] available: http://www.gla.ac.uk/departments/sociology/units/media/cultural.htm [last accessed 12/12/05]

PMI (1996) *Guide to the Project Management Body of Knowledge* Pennsylvania: Project Management Institute Inc

POPPER (1959) *The logic of scientific discovery* London: Hutchinson

PRING (2000) *Philosophy of educational research* London: Continuum

PRITCHETT, N. (1999) Effective Question Design. IN: BROWN, S., RACE, P. & BULL, J. (eds), *Computer-assisted assessment in higher education*, Kogan Page, London.

QAA (1998) *University of Bath Quality Audit Report, May 1998*. [online] available: http://www.qaa.ac.uk/revreps/instrev/bath/comms.htm [last accessed 4.9.03]

QAA (2000) *Code of practice for the assurance of academic quality and standards in higher education*. [online] available: http://www.qaa.ac.uk/academicinfrastructure/codeOfPractice/section6/default.asp [last accessed 12/12/05]

QCA (2005) *Analysis of pupil performance 2005*. [online] available: http://www.qca.org.uk/12305_12536.html [last accessed 12/12/05]

QUESTIONMARK (2004) *Perception: Windows Based Authoring*. [online] available: http://www.questionmark.com/uk/perception/authoring_windows.htm [last accessed 29-8-2004]

QUINTON, A. (1978a) Demonstration. IN: BULLOCK, A. & STALLYBRASS, O. (eds), *The Fontana Dictionary of Modern Thought*, Fontana, London, pp. 162-163.

QUINTON, A. (1978b) Induction. IN: BULLOCK, A. & STALLYBRASS, O. (eds), *The Fontana Dictionary of Modern Thought*, Fontana, London, p. 306.

RACE, P. (1993) *Quality of assessment*. [online] available: http://www.lgu.ac.uk/deliberations/sedapubs/Race.html [last accessed 12/12/05]

RAINE, J. (1999) Towards the introduction of institution-wide computer assisted assessment: a service department experience. IN: DANSON, M., ed., *Proceedings of 3rd International CAA Conference*. Loughborough, University of Loughborough.

RENNIE, D. L. (2000). Grounded theory methodology as methodical hermeneutics: Reconciling realism and relativism. *Theory & Psychology,* 10, pp. 481-502.

REUSHLE, S. & MCDONALD, J. (2004) *Role of the Educator in Supporting Learning in an Online Environment – Vision for the Future*. [online] available: http://www.usq.edu.au/users/reushle/Resources/reushleICCE2004.pdf [last accessed 14/12/05]

ROBBINS, P. (2003) *Understanding Psychology* Portland, MN: Walch

ROGERS, E. M. (2003) *Diffusion of Innovations* 5th edn. New York: Free Press

ROSS, A. (2000) *Curriculum: Construction and Critique* London: Routledge

ROWNTREE, D. (1981) *Statistics without tears* London: Penguin

RUSSELL, B. (2000) *History of Western Philosophy* 3rd edn. London: Routledge

SAETTLER (1968) *History of instructional technology* New York: McGraw-Hill

SCLATER, N., CONOLE, G., WARBURTON, W., WHITELOCK, D. & HARVEY, J. (forthcoming) eAssessment. IN: CONOLE, G. & OLIVER, M. (eds), *Contemporary E-Learning*, Routledge London.

SCLATER, N. & HOWIE, K. (2003) User requirements of the "ultimate" online assessment engine. *Computers in Education*, vol. 40, no. (3), pp. 285–306.

SCLATER, N., LOW, B. & BARR, N. (2002) Interoperability With CAA: Does It Work In Practice? IN: DANSON, M., ed., *Proceedings of 6th International CAA Conference*. Loughborough, University of Loughborough.

SENGE, P. (1990) *The Fifth Discipline* London: Century Business

SHATTOCK, M. (2003) *Managing successful universities* Buckingham: Society for Research into Higher Education & Open University Press

SHEPHARD, K., WARBURTON, W., WARREN, A. & MAIER, P. (In press) Preparing for BS7988; developing and evaluating computer-assisted assessment in higher education. *Assessment & Evaluation in Higher Education*, forthcoming

SHEPHERD, E. (2001) *Assessment Stakes*. [online] available: http://www.questionmark.com/uk/learningcafe/lowmediumandhighstakesassessments.ppt [last accessed 19.8.03]

SILVERMAN (2000) *Doing Qualitative Research: A Practical Handbook* London: Sage

SIMONSON, M. (2004) *An Applied Research Agenda for Instructional Technology and Distance Education*. [online] available:

http://www.schoolofed.nova.edu/itde/pdf/faculty/research-agenda-simonson.pdf [last accessed 30-11-2004]

SMITH, C. (2004) *The role of ICT in widening participation*. [online] available: http://www2.warwick.ac.uk/services/cap/resources/eguides/elearning/widening/ [last accessed 14/12/05]

SOMMERLAD, E., PETTIGREW, M., RAMSDEN, C. & STERN, E. (1999) *Synthesis of TLTP annual reports*, Tavistock Institute, London.

STEINAKER & BELL (1979) *The experiential taxonomy a new approach to teaching and learning* New York: Academic Press

STEPHENS, D. & MASCIA, J. (1997) *Results of a (1995) Survey into the use of Computer-Assisted Assessment in Institutions of Higher Education in the UK*. [online] available: http://www.lboro.ac.uk/service/ltd/flicaa/downloads/survey.pdf [last accessed 11-5-03]

STRAUSS, A. & CORBIN, J. (1990) *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* 1st edn. London: Sage

STRAUSS, A. & CORBIN, J. (1998a) *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* 2nd edn. London: Sage

STRAUSS, A. & CORBIN, J. (1998b) Grounded Theory Methodology: An Overview. IN: DENZIN, N. & LINCOLN, Y. (eds), *Strategies of Qualitative Inquiry*, Sage, London.

SURRY, D. W. & FARQUHAR, J. D. (1997) Diffusion theory and instructional technology. *Journal of Instructional Science and Technology*, vol. 2, no. (1), pp. 24-36.

TARDE, G. (1962) *The Laws of Imitation* trans. PARSONS, E. C. Reprint edn. Gloucester, MA: Peter Smith

THE CONSERVATIVE PARTY (2003) *Labour's corrosive 'dumbing down' of education*. [online] available: http://www.conservatives.com/tile.do?def=news.story.page&obj_id=52096&speeches=1 [last accessed 14/12/05]

THES (1998) *Too loving spoonfuls*. [online] available: http://www.thes.co.uk/search/story.aspx?story_id=53857 [last accessed 19-12-98]

THES (2002a) *Cheque-book entry' rejected*. [online] available: http://www.thes.co.uk/search/story.aspx?story_id=88734 [last accessed 28-12-05]

THES (2002b *Universities blamed for exam fiasco*. [online] available: http://www.thes.co.uk/search/story.aspx?story_id=87849 [last accessed 28-12-05]

THES (2003) *Legal fear over degree plan*. [online] available: http://www.thes.co.uk/search/story.aspx?story_id=2008346 [last accessed 20/12/03]

THES (2004a) *High on class, low on content?* [online] available: http://www.thes.co.uk/search/story.aspx?story_id=2017968 [last accessed 26-11-04]

THES (2004b) *Degree grades show dumbing down*. [online] available: http://news.bbc.co.uk/1/hi/education/3515984.stm [last accessed 17/3/2004]

THES (2004c) *Middlesex abolishes exams for first-years*. [online] available: http://www.thes.co.uk/search/story.aspx?story_id=2016400 [last accessed 15-10-04]

THES (2004d) *Degree classifications overhaul planned*. [online] available: http://www.thes.co.uk/search/story.aspx?story_id=2016892 [last accessed 05/11/04]

THES (2004e) *Don't ignore unhappy students*. [online] available: http://www.thes.co.uk/search/story.aspx?story_id=2011902 [last accessed 27/3/04]

THES (2004f) *PhD code could lead to a rise in legal actions*. [online] available: http://www.thes.co.uk/search/story.aspx?story_id=2016450 [last accessed 15-12-04]

THES (2005a) *Complaint culture grows on campus*. [online] available: http://www.thes.co.uk/search/story.aspx?story_id=2024030 [last accessed 30-8-05]

TILLMANN, I. (2003) *Strategic Management Accounting and Sense Making: A Grounded Theory Study*, Unpublished PhD thesis, University of Southampton.

THES (2005b) *Student poll puts staff under pressure*. [online] available: http://www.thes.co.uk/search/story.aspx?story_id=2024693 [last accessed 23/10/05]

THES (2005c) *Finger points to Bath copycats*. [online] available: http://www.thes.co.uk/search/story.aspx?story_id=2018981 [last accessed 19-12-05]

THOMAS, R., ASHTON, H., AUSTIN, W., BEEZERS, C., EDWARDS, D. & MILLIGAN, C. (2005) Assessing Higher Order Skills Using Simulations IN: DANSON, M., ed., *Proceedings of 9th International CAA Conference*. Loughborough, University of Loughborough.

TIMMIS, S. (2003) *Embedding Learning Technology Institutionally*, JISC, London.

TIMMIS, S., BEETHAM, H., BAILEY, A., CONOLE, G., JONES, S. & GORNALL, L. (2003) *The ELTI Facilitator's Guide: A Workshop Pack for Higher and Further Education*, University of Bristol, Bristol.

TOIA (2004) *The TOIA Project*. [online] available: www.toia.ac.uk [last accessed 31.8.04]

TURNBULL, N. (1999) *Get a Grip on Philosophy* London: Weidenfeld & Nicolson

WACHALA, K. (2001) *Changing perceptions and needs of legal education and the usefulness of Iolis in these changing times*. [online] available: http://www.bileta.ac.uk/01papers/wachala.html [last accessed 12/12/03]

WARBURTON, W. (2002) *What distinguishes excellent instructors?*, Unpublished Masters dissertation thesis, University College Winchester.

WARBURTON, W. (2005) *What are grounded theories made of?* [online] available: www.eprints.soton.ac.uk/16340/ [last accessed 28.7.05]

WARBURTON, W. & CONOLE, G. (2003a) *Key Findings from Recent Literature on Computer-aided Assessment*. [online] available: http://eprints.soton.ac.uk/14113/01/CAAlitrev4.pdf [last accessed 12/12/03]

WARBURTON, W. & CONOLE, G. (2003b) CAA in UK HEIs: The State of the Art. IN: CHRISTIE, J., ed., *Proceedings of 7th International CAA Conference*. Loughborough, University of Loughborough.

WARBURTON, W. & CONOLE, G. (2005) Wither e-Assessment? IN: DANSON, M., ed., *Proceedings of 9th International CAA Conference*. Loughborough, University of Loughborough.

WARBURTON, W. & HARWOOD, I. (2004) Implementing Perception across a large University: getting it right. IN: *Proceedings of Perception European Users Conference*. Edinburgh, Questionmark Computing.

WIKIPEDIA (2005a) *List of Greek words with English derivatives*. [online] available: http://en.wikipedia.org/wiki/List_of_Greek_words_with_English_derivatives [last accessed 17-12-05]

WIKIPEDIA (2005b) *Substantive*. [online] available: http://en.wikipedia.org/wiki/Substantive [last accessed 17-12-05]

WILSON , G. & STACEY , E. (2004) Online interaction impacts on learning: Teaching the teachers to teach online. *Australasian Journal of Educational Technology* vol. 20, no. (1), pp. 33-48.

ZAKRZEWSKI, S. & STEVEN, C. (2000) A Model for Computer-based Assessment: the Catherine wheel principle. *Assessment & Evaluation in Higher Education*, vol. 25, no. (2), pp. 201-215.

ZAKRZEWSKI, S. & STEVEN, C. (2003) Computer-based Assessment: quality assurance issues, the hub of the wheel. *Assessment & Evaluation in Higher Education*, vol. 28,, no. (6), pp. 609-623.

Published peer-reviewed papers

HARWOOD, I. & WARBURTON, W. (2004) Thinking the Unthinkable: Using Project Risk Management when Introducing Computer-assisted Assessments. IN: DANSON, M., ed., *Proceedings of 8th International CAA Conference*. Loughborough, University of Loughborough.

SHEPHARD, K., WARBURTON, W., WARREN, A. & MAIER, P. (In press) Preparing for BS7988; developing and evaluating computer-assisted assessment in higher education. *Assessment & Evaluation in Higher Education*, forthcoming

WARBURTON, W. (2005) *What are grounded theories made of?* [online] available: www.eprints.soton.ac.uk/16340/ [last accessed 28.7.05]

WARBURTON, W. & CONOLE, G. (2005) Wither e-Assessment? IN: DANSON, M., ed., *9th International CAA Conference*. Loughborough, University of Loughborough.