

2

Critical Enquiry in Computer Science Education

Tony Clear

Introduction

Critical enquiry is a term for a school of somewhat controversial research methods. Although very rarely used in the computer science (CS) field, it is a rather more common research approach in other disciplines, especially in education and various fields of social science research. Yet in the computer science discipline, the core methods of research offer a rather limited repertoire for the inherently transdisciplinary endeavour of CS education research. To support this different range of research topics and goals it is necessary to extend the traditional repertoire by borrowing methods from other disciplines. *Critical enquiry* represents one alternative family of methods, which can be used to support different forms of enquiry in CS education research.

Is There Research Beyond The “Normal Science” Paradigm?

Critical enquiry can be thought of, not so much as a research method or group of research methods, but as a distinct research “paradigm” (Kuhn, 1962), with its own worldview and set of beliefs about the nature of knowledge and truth. As a paradigm it may be positioned within the three broadly recognised paradigms of research (Melrose, 1996, Orlikowski & Baroudi, 1991, Carspecken, 1996 p. 20, Clear, 2001c) outlined below:

- The *scientific/scientistic* (sometimes also called the *objective* or the *positivistic* approach). This research paradigm is usually typified by the making of formal hypotheses, and the use of quantitative methods to assess their validity. Conclusions are normally drawn negatively, and stated in terms that imply that the hypothesis has not (for now) been disproven, so it can be assumed to hold true. [This represents the primary “normal science” (Kuhn, 1962) research paradigm within which most computer *scientists* have been schooled.]
- The *interpretivistic* (sometimes called *subjective* approach). This research method often tries to understand complex phenomena which cannot readily be

analysed in a fragmented way, such as social systems, societies or aspects of individual lives. Hypotheses may or may not be used, but the measurement techniques often elicit opinions and feelings and involve more qualitative measures, in an attempt to more broadly understand the whole phenomenon under study.

- The *critical* method, which has an explicitly *emancipatory* mission, with an interest in addressing issues to do with power imbalances and liberation from unwarranted forms of constraint - thus a concentration on a particular aspect of the *benefit to mankind* dimension of research, as opposed to simply *adding to our stock of knowledge*. This method while basically *interpretivistic*, often combines some *positivistic* approaches.

How Might Critical Enquiry Contribute To Computer Science Education Research?

Enquiry using the critical method enables a different set of research questions to be addressed. It is particularly useful when investigating issues in which a power imbalance is present, leading to marginalisation of those involved in the situation and where research methods based upon traditional scientific assumptions will normally not challenge but merely reinforce an unsatisfactory status quo.

Some of the critical questions in CS education research relate to: the paucity of women studying the discipline (Camp, 2002); understanding the barriers to study for minorities in the discipline (Barker et al., 2002, Rocco, 1998, Billings, 2003); how to teach the discipline in a manner that empowers and motivates the learners (Robinson, 1994, Smith, Mann et al., 2001); the application of information technology in a manner that transforms the learning experience (Clear, 2000); the rise of consumerism in computing education (Clear, 2002c); the barriers to sharing the experience and insights of seasoned IT practitioners in the academy (Clear, 1999c, Clear & Young, 2002); adjustment strategies for both computing educators and learners from other cultures in an increasingly internationalised learning context (Billings, 2003, Chamberlain & Hope, 2003).

These tend to be broader issues than simply applying a new teaching technique or an innovative technology in teaching a specific computing subject. While evaluation of such educational innovations can in themselves prove challenging (cf. Almstrum et al., 1996, Bain, 1999), selecting and applying suitable research techniques to explore the set of questions posed above requires a much broader armoury. Critical enquiry with its holistic approach, its focus on analysing imbalanced power structures, how they are reinforced and sustained, and its often activist and interventionist strategies to effect meaningful change, provides a set of tools for researchers seeking to branch out beyond those approaches that may have served them in the Computer Science discipline itself.

So What Do We Mean By Critical Enquiry?

The research strand known as *critical enquiry*, has developed from the critical social theory, of Jurgen Habermas (cf. Habermas, 1972, 1984, 1989 and Held, 1980) and his colleagues in the "Frankfurt School" of critical social theorists, cf. Held. (1980). For a reader new to critical social theory the language can prove a barrier, typically being written so densely that as Carspecken (1996, p. 4) comments: "This has made work in the critical tradition basically inaccessible to a large number of people". The aim of this chapter is to provide an accessible introduction to critical theory, and situate its relevance within CS education research.

The critical social theory of Habermas is based upon his "theory of cognitive interests." In this theory Habermas as a neo-marxist defines human beings from a basis of historical materialism, as labouring, toolmaking and language using animals, the basic activities through which humans produce and reproduce their species. These it is argued furnish man with an *a priori* set of interests. These three interests it is argued (cf. Held, 1980) are: 1) the *technical* interest associated with tool making, 2) the *practical* interest in creation of knowledge so that control of objectified processes and maintenance of communication can occur to support the technical interest; 3) the *emancipatory* interest, a reflective interest, which enables insight into the character of knowledge itself. This interest in reason, in the human capacity to be self reflective and self-determining, to act rationally generates knowledge, which enhances autonomy and responsibility and is hence an *emancipatory* interest.

These three interests are said to unfold in three media - work (instrumental action), interaction (language) and power (asymmetrical relationships of constraint and dependency), and give rise to the conditions for the possibility of three sciences, the empirical analytic, the historical-hermeneutic and the critical.

Carr & Kemmis (1983) represent these interests diagrammatically thus:

Table 1 The knowledge constituted interests of Habermas

Interest	Knowledge	Medium	Science
Technical	Instrumental (causal explanation)	Work	Empirical-analytic or natural sciences
Practical	Practical (understanding)	Language	Hermeneutic or 'interpretive' sciences
Emancipatory	Emancipatory (reflection)	Power	Critical sciences

From this foundation Habermas (1984) developed his 'theory of communicative competence' in which he posits the notion of all speech as oriented to a genuine rational consensus, the *ideal speech situation*, which is rarely realized (cf. Wilson, 1997). This ideal speech situation then becomes the ultimate criterion of the truth of a statement or the correctness of norms, creating an underpinning for critical theory grounded in the very structure of social action and language. The notion of an ideal form of discourse then can be used as a standard for a critique of distorted communication. "It is Habermas's contention that in every communicative situation in which a consensus is established under coercion or under other similar types of condition, we are likely to be confronting instances of systematically distorted communication." (Held, 1980)

What Does It Mean To Be A "Modernist"?

While Habermas provides the theoretical basis for most critical social theory, his work is not without its critics. Positioning his work in the modernist versus postmodernist debate, reveals some contradictions in critical theory itself. Taket & White (1993) describe the phenomenon of modernism as resting "on a belief in the capacity of humanity to perfect itself through rational thought. The modern is exemplified by the criteria of progress and reason." Computer science therefore can be considered as a 'modern' discipline.

Modernism has been further described in two modes, 'the systemic and the critical'. In the *systemic* mode knowledge and information are organising principles in effecting social control and directing change. The *critical* mode of modernism, by contrast works against this mechanistic process with a liberating rather than controlling purpose. This purpose is effected by working to liberate the so called 'lifeworld', a difficult but crucial concept which is explained below.

This central concept of a 'lifeworld' describes a certain integrity of views derived from "life experiences and beliefs which guide attitudes, behaviour and action. The three main forms of the lifeworld are culture, society and personality" (Myers & Young, 1997). These lifeworlds are said to be held together through 'systems' and 'steering media'.

As an example, a mental health systems study by Myers & Young (1997) depicts the lifeworlds of doctors, nurses, systems analysts, hospital managers and Health service administrators, each having their own distinct characteristics.

The concept of *systems* in a lifeworld is important, as identifiable spheres of action, with economic and administrative systems being primary. These in turn are guided “by lifeworld concerns and held together by the steering media of money and power” (Wilson, 1997). Habermas proposes that it is normal for the steering media to steer the societal systems in ways consistent with life world demands. But “it is possible for the steering media to ‘get out of hand’ and to steer the societal systems in ways which is at odds with lifeworld demands. This process is called the ‘internal colonization of the lifeworld.’” (Myers & Young, 1997).

In the mental health study above the lifeworlds of managers and health professional differed greatly, with managers focusing on efficiency and monitoring, and health professionals focussing on care. The systems designers in implementing a system to support managers’ wishes, were inherently enrolled in an agenda which would “colonize the lifeworlds” of the health professionals. Such a process inherently represents a distortion of communication, and the role of modernist critical theory is to uncover and address such distortions, by developing theoretical approaches to enable collective emancipation, by improving the lot of others.

What On Earth Is A Postmodernist Anyway?

By contrast the postmodern perspective “attacks all that modernity has ‘engendered’; for example civilisation, industrialization, urbanization and technology. It challenges the values and objects of modernism such as individual responsibility, liberal democracy, ...rationality, quality, evaluative criteria and impersonal rules” (Taket & White, 1993). Distrusting modernity and seeing it as an oppressive rather than a liberating force, it does not favour any one credo over another such as Marxism, capitalism, humanism, or Christianity, and is opposed to the enlightenment ideal of progress of mankind through science, dismissing it as a form of thought control, a totalizing “grand narrative”.

Reflecting these distinctions in part, two lines of emancipatory thought in critical theory can be discerned, the first based upon the work of Jurgen Habermas, the second based upon the work of Michel Foucault. Foucault's approach shares the profound scepticism of this postmodern world, and is more concerned with providing tools through which individuals can make visible the hidden ways in which they are constrained by power structures and develop personally empowering strategies in response. “Fundamentally, the issue is *human* emancipation or *self* emancipation” (Brocklesby & Cummings, 1996). This then, seems a very individualistic model of critical theory.

Foucault does however acknowledge the significant role of institutions in giving life structure and pattern through regular forms that are amenable to rational analysis. Thus there may not be a truthful 'grand narrative', but there may well be compelling local narratives to be analyzed and worked with. The focus then is on the individual thinker in the local context, applying specific local knowledge. By this focus on the individual as a critical thinker, Foucault undermines the role of the

expert as therapist, as the solver of others' problems. Brocklesby & Cummings (1996) "Local' people possess the *reason*, but after years of being conditioned to privilege and defer to, the world of experts they lack the *resolution* and *courage* to employ their own reason. Critical theory should enable individuals to regain such courage".

So what precisely do these different views mean for a critical researcher? The Habermas inspired model addresses situations of collective disempowerment, by the expert researcher undertaking a theoretical critique, but it seems a little detached. The step from critique to action appears missing, and the role of political action is left to the subjects of the research to initiate. By contrast the Foucault inspired model has no actively democratising motivation. In opposition to the desire of Habermas to reduce power differentials, in fact, Foucault sees power as an active and positive force productive of social relations. The Foucault model is potentially "empowering" in the sense that each individual can choose to apply the tools generated from critique to a form of self-liberation in their local context. But it seems rather bleak, and in the absence of a value system, or some overall goal of improvement, perhaps even pointless. So the contrasts between the two theories are stark -- hopeless idealism on the one hand and bleak nihilism on the other.

How Does Critique Engender Action?

In a move from these positions towards pragmatic activism, the research approach known as *action research* strives to offer one set of solutions. The Australian educational action researchers Carr & Kemmis (1983) define action research as:

a form of self-reflective inquiry undertaken by participants in social (including educational) situations in order to improve the rationality and justice of (a) their own social or educational practices, (b) their understanding of these practices, and (c) the situations in which the practices are carried out. It is most rationally empowering when undertaken by participants collaboratively, though it is often undertaken by individuals and sometimes in cooperation with 'outsiders'

Action research activity is said by Carr & Kemmis (1983) to have two essential aims, both to *improve* and to *involve*. The focus of this improvement lies in three key areas: improving a practice; improving the *understanding* of a practice by practitioners and improving the *situation* in which the practice takes place. Three kinds of action research are delineated: technical, practical and emancipatory (or critical), mapping to the three broad research "paradigms", outlined at the beginning of this chapter. Yet through these different methods legitimate forms of knowledge may be determined which reflect the perceptions and beliefs of the inquirer. As "Habermas...points out, knowledge and human interests are interwoven, as reflected in the choice of methods and the ends towards which such methods are put" (Susman & Evered, 1978).

Where Has Critical Inquiry Been Used?

For researchers with an interest in applying the techniques of critical enquiry within CS Education research, there is a large body of critical literature in the education field. For instance the work on critical ethnography by Carspecken (1996) is one of a series of books on critical social thought edited by Michael Apple, a noted educationist and critical researcher within the education field (cf. Apple, 1979, 1983, 1986, 1993). Rocco (1998) offers a good example of a study into the role of “privilege” in adult education. In the educational technology area useful resources are: the review of evaluation paradigms for instructional design by Reeves (1997); the *Educational Technology* Special Issue on The Ethical Position of Educational Technology in Society (Yeaman, 1994); and Clear (2002c) is an example of an Educational Technology/CS Education Research article applying a critical perspective. In the Operations Research Literature Taket (1993) & White (1994) explore the nature of expert power as employed by traditional operations researchers, and the distinction between the modern and postmodern perspectives. In the Information Systems literature there are a wide range of resources applying a critical social perspective (Hirscheim & Klein, 1989, Flood & Ulrich, 1991, the *DATABASE* Special Issues on Critical Analyses of ERP Systems (Howcroft and Truex, 2001, 2002), the Journal of Information Technology special issues on critical research in information systems (Brooke, 2002a, 2002b), the Information Technology and People special issue on gender and IS (Adam, 2002), and work by Myers (1995, 2000), Myers & Young (1997). In the IS World site Myers (2000) provides an online resource with comprehensive coverage of qualitative research methods which includes approaches to critical enquiry for scholars in Information Systems.

A long established critical strand within the computing literature is the work based upon the Scandinavian social democracy movement, and participatory design, cf. the *Communications of the ACM* special issue on participatory design (Kuhn & Muller, 1993). There is a strong critical thread within the action research literature in education, where work with groups of educators to change the status quo is a frequent emphasis of such research, cf. Carr & Kemmis (1983), Zuber-Skerrit (1996), Melrose (1996, 2001). Participatory action research with communities in such contexts as developing countries is explored by Elden & Chisholm (1993) in a special issue of *Human Relations*. In nursing research where the issues of institutional and professional power and patient needs often conflict, there is a well-developed body of research from a critical perspective (cf. Campbell & Bunting, 1991, Duffy, 1985, Kaminski, 2002, Browne, 2000, Mill et al. 2001). In the nursing discipline “creating a safe environment to talk about sexuality” (Glass & Walter, 1998) represents an example of one sensitive issue and a research approach by which it may be explored. Feminist literature too has its own strong social critical strand, exploring issues to do with gender, difference, societal structures and power (cf. King, 1994, Switala, 1999, Hedges, 1997). Topics such as “prostitution as work” (O’Neill, 1996), “cyberfeminism” (Gur_Ze’ev, 1999), and “feminist pedagogy” (Christie, 1997) are examples of critical feminist writing.

Why A Critical Approach?

Critical modes of enquiry have developed in a broad range of disciplines especially the social sciences, where the perceived ‘objectivity’ and ‘neutrality’ of traditional scientific modes of enquiry have been increasingly called into question. In fact, Carspecken (1996 p. 7) argues that “much of what has passed for neutral objective science is in fact not objective at all, but subtly biased in favour of privileged groups”. He uses the history of intelligence tests as one example of the misuse of science by which minorities and the poor are frequently negatively labelled and by means of which “diagnosticians...unconsciously use the products of purportedly neutral research to support and expand a system that discriminates and oppresses.”

For researchers in the CS education field it is vitally important to confront the inherent biases of an educational background strongly based, as it typically is, in traditional scientific beliefs and practices. In CS education we are dealing not simply with the issues of the discipline, but the nature of our students and their learning. This inherently involves the whole person, the cultural and institutional context, and the constraints imposed by contending forces within the learning situation. The CS education researcher needs an extended set of research approaches to enable inquiry into these broader issues of the social, the professional and the personal. Critical enquiry then, is a research orientation which offers a means for researchers to address issues to do with power, inequality, and forms of oppression, including those subtle forms of oppression sustained “by mainstream research practices” (Carspecken, 1996 p. 7).

For instance a critical perspective may have much to add to inquiries into inequity within the discipline, such as the research stream of “women in computing” (Camp, 2002, Cukier, Shortt et al., 2002). There are occasional examples of critical feminist approaches in this research endeavour (Estrin, 1996, Adam, 1996, Adam, 2002) but they are rare in a computer science context, perhaps because “professorial women in S&E fear that any commitment to feminist studies will make them appear peripheral to traditional science and lessen their chances for promotion and tenure” (Estrin, 1996). Yet critical enquiry enables a different stance to be adopted by the researcher, and offers a different set of tools and techniques to support broader forms of enquiry and critique.

Nonetheless critical enquiry in the service of an emancipatory research agenda must be entered into with some care, as it is itself open to criticism. Bishop for instance has commented, “Within the neo-Marxist emancipatory paradigm, a position developed to critique the ‘distanced’, ‘objective’ and impositional positivist paradigm, there is an inherent tendency for researchers themselves to initiate emancipatory research for those whom they consider to be oppressed and to direct attention to the possibilities for ‘social transformation’. The intellectual arrogance of such theory-driven emancipationists has contributed to a new form of evangelism” (Bishop, 1996, p. 56).

Illustrative Cases

The three cases that follow present examples of critical enquiry in CS education, and briefly overview the nature of the enquiry, the basis and methods for its conduct, and

the techniques applied. These may suggest ways in which a critical research approach could be adopted, by those interested in exploring further.

International Collaborative Learning – Learning as Transformation?

This case profiles the author's own research, conducted as an ongoing action research programme, involving international collaboration between students in New Zealand and Sweden, through a series of groupware trials in which the students work together in virtual groups to achieve common goals, (Clear, 1998, 1999a, 1999b, 2000, 2002a, 2002b) and (Clear & Daniels, 2000, 2001). The focus of this case is the action cycle of semester 2 1999, the second international trial between Auckland University of Technology (AUT) and Uppsala University which was reviewed in the author's thesis (Clear, 2000).

The dual cycle action research model of McKay and Marshall (1999, 2001), depicted in table 2 below, offers a useful framework within which to analyse the research. This model deliberately distinguishes between the real world practical problem solving elements of action research and its research oriented dimensions.

Table 2: Elements of Dual Cycle action research

Research Interest	Problem Solving Interest
A - a real world problem situation potentially of interest to the research themes of the researcher	P - a problem situation in which we are intervening
M_R - research method	M_{PS} - problem solving method
F - a theoretical framework	

In the research cycle reviewed here the distinct elements of the research are identified in table 3 below, applying the model of McKay & Marshall (1999, 2001). This summary of the research cycle, shows the relative complexity of the activity, the combined theoretical and problem solving dimensions of the research, and a degree of uncertainty regarding the research method itself. This partly reflects the fact that this framework is basically an analytical structure, overlaid upon the research after the event. It also results from a process of personal reflection by the author about the degree to which the research truly represented a *critical* or *emancipatory* model of action research. In a *practical* action research model, the researcher facilitates reflection by individual practitioners upon some aspect of their practice. In an *emancipatory* action research model a community of practitioners jointly negotiate goals and work to effect changes in the status quo. This issue will be explored further below.

Table 3: elements of the action research intervention Auckland - Uppsala second collaborative trial, Semester two 1999

Element	Description
F (Framework)	<i>(Theoretical bases informing conduct of the research)</i> Problem Based learning Adaptive Structuration Theory & Extended AST An Integrative Model of Group Interaction
M_R (Research Method)	Practical Action Research, (Loosely framed), combining elements of Emancipatory action research
M_{PS} (Problem solving method)	Practical Action Research, (Loosely framed), Prototyping
A - (problem situation of interest to the researcher)	To explore the structuring process for discussions and other communication, coordination, and collaboration facilities using the generic collaborative database To explore the moderator's role, the role of structure and the facilitation process using the collaborative database To improve understanding of groupware and Lotus Notes features, how to apply them, Notes' technical infrastructure and development process Alpha? Testing & Improving functionality in the prototype collaborative database To evaluate the effectiveness of the design concept of the database and explore the appropriation processes used by individuals and groups To explore methods of linking research and teaching
P - a problem situation in which we are intervening	Improving teaching & learning Developing student capabilities in teamwork, cross cultural communication and use of IT Providing an interesting & meaningful learning experience Using the collaborative database to teach and practically demonstrate key concepts of groupware and group decision support To perform a group ranking task Validating viability of collaborative databases for use by work teams or students engaged in international groupwork

During the “reflect” phase (Carr & Kemmis, 1983) of the action research cycle, or the phase of “specifying learning” (Susman & Evered, 1978) it became apparent to the author that there were some tensions inherent in the research context. These potentially invalidated the notion of the research as a model of true *emancipatory* action research. Now in order to support this process of *reflection* and *specifying*

learning from the action cycle, as in any research model, the relevant data had to be selected and appropriate analysis had to be undertaken. But what is the nature of data in critical action research? In the process of exploring this question a taxonomy of data was derived, and these differing forms of data were represented in the structure of the author's thesis. "The early chapters presented the *historical and contextual* data, intermediate chapters the *process* of the action research, and the following chapters addressed the *empirical* and *evaluative* forms of data. This taxonomy is proposed in the table below, with illustrative examples given for each class of data." (Clear, 2000)

Table 4: A taxonomy of data in critical action research

Taxonomy of Data Types for Critical Action Research Projects			
Historical and Contextual	Process	Empirical	Evaluative
Examples of forms of data in this project			
Various AUT internal documents	Selected journal articles	Group membership details	Lecturer & course appraisals
Mission statements	Instructions & Timeline for Collaboration	Online evaluation questionnaires	Reflective reports, conference & journal articles
Research reports	Participant Information Sheet	Scoring, individual & group ranking entries	Student assignment reflective analyses
Strategic plans	Consent form	Online logbook entries	Reeves analysis in class
Teaching & Learning Development Plans	Complaint correspondence	In class email survey results	Personal reflection
Policy documents	Ethics approval documents & correspondence	Discussion postings & email messages	Reflective exam questions & Student responses
Programme reports	Database design notes & features	Attached files	Latent Discourses
Newspaper & magazine articles	Discussions in class and related email	Design proposals	Technical reports
Correspondence - research grants, innovative teaching awards etc.	Class presentations, module handbook, course handouts, course text extracts	Website links	Journal articles (online & offline)
newsletters	Database changes Database entries		Dilemmas Emancipatory questions

In analysing the *evaluative* forms of data, an inherently difficult question is the issue of how and where to focus the analysis. Two useful techniques were dilemma analysis (McKernan, 1991) and critical incident technique (Chell, 1998). Dilemma analysis was used as a mechanism to tease out opposing poles of an issue, as a dialectic technique to identify significant tensions and explore the wider social

structures of which they were part. The incidents isolated by critical incident technique, provided grounded data to inform the dilemma analysis.

The benefit of this method was its ability to draw the links between discrete, tangible events and broader societal structures, and thus bring into effect the principle of the *hermeneutic circle* (Klein & Myers, 1999). The *hermeneutic circle* is a key analytic principle in qualitative research, which provides for a form of triangulation of findings by confirming consistency of interpretations between the part & the whole. Hermeneutic analysis has been used heavily in researching biblical texts, and I like to think of it as the “zoom-in”, “zoom-out” principle, whereby the researcher looks at the detail in depth and then zooms back out to the big picture to check for consistency of findings. The cycle may repeat several times until the meanings cohere. As an example of this form of analysis, during the research programme the author received a student complaint about the research project, its relevance to the course, and the fact that students were “customers” and “locked into the degree.” This critical incident sparked considerable personal reflection.

One key issue that emerged was the power differential inherent in the teaching/student relationship. Consequently was this transformative model of learning a jointly chosen course of action, in which students and teachers became co-researchers using Information Technology to enable new forms of learning experience. Did it represent an emancipatory action research model, or merely a teacher imposed piece of whimsy, resented because it did not directly generate credit towards the course.

The other key issue arising from this incident was the dilemma represented in the form of two broader “discourses”, the *discourse of enterprise* versus the *discourse of community* (Clear, 2002c). Foucault's (1980) concept of a *discourse* is described below.

A discourse is a regulated system of statements and practices that defines social interaction. The rules that govern a discourse operate through language and social interaction to specify the boundaries of what can be said in a given context, and which actors within that discourse may legitimately speak or act” (Davies & Mitchell, 1994).

Thus a discourse both enables and constrains social action and acts to reinforce structures of power. But "a discourse is determined by community, it is also embedded in the larger framework of social relationships and social institutions" (Jennings & Graham, 1996). In this collaborative research project, situated within a wider social context, identifying some of the key discourses in operation, how they act to enable/restrain possibilities, and how they conflict with one another, has been a means of broadening our perspectives on the research undertaking.

The distinction drawn here between the *discourse of enterprise* versus the *discourse of community* is that between education as a personal economic good, an investment in the self, with educators as providers of services to student *customers*; or education as a social responsibility, from which the community derives benefit and with many stakeholders interests to be balanced in the moral choices of professional educators. In AUT's model of quality “Education is a participative

process, students are not products, consumers or customers. They are participants” (Horsburgh, 1996). Thus power does not lie solely with the student, the curriculum is not totally negotiable, so the emancipatory ability of educational action research may be limited, when the ‘peer community’ is not a community of equals, as it may be when working with professional colleagues. However by adopting an open approach, which makes visible these power imbalances, and by the use of a contracted learning model conducted within “a mutually acceptable ethical framework” (Susman & Evered, 1978), it is possible to conduct teaching, learning & research in a mode that has an emancipatory dimension.

Crashing a Bus Full of Empowered Software Engineering Students?

This case provides another New Zealand example, in which the teaching of a software engineering course on Otago Polytechnic’s Bachelor of Information Technology (Smith et al., 2001), was informed by the attitudes and practices of an “empowering education” model (Robinson, 1994). The table below depicts a few elements of the model.

Table 4. Attitudes and Practices of Empowering Education

- a) The teacher and students both teach and are taught by each other
- b) The teacher is aware of not knowing everything and is open to the student’s knowledge and experience which are actively valued
- h) The teacher and the students together decide on programme content and revise and change it as their interests and needs change
- j) The teacher and students form a collective Subject of the learning process, sharing joint ownership of the classroom life

The design of the software engineering course involved the application of a catastrophic change in project to an otherwise successful course. “The class was ‘run over by a bus’ and groups were required to swap projects halfway through development” (Smith et al., 2001). This design was intended to emulate the commercial environment in which individual software engineers would rarely see a project through its entire development, from planning to implementation.

The aim of this research was firstly to attempt to replicate and document in more detail the positive findings of an earlier study (Surendran and Young, 2001) with regard to swapping projects; and secondly to assess this practice in terms of Robinson’s empowering paradigm.

In order to establish the initiative on a sound footing, ethics committee approval was sought and gained, both for the study itself using a control group (only six of the ten groups were required to swap); and for the need to change an assessment in the middle of the course - i.e after the run over by a bus event (ROBAB), about which students were only warned to the extent that their projects might take ‘unpredictable turns’. While a degree of deception was inherent in this learning

design, consistent with the concept of informed consent, students included the following statement in their management document, “All members of this group are aware that our experiences in undergoing this research project may be used in research into teaching methods for software engineering. We understand that identities will be confidential and that taking part in this research is entirely voluntary and will not affect in any way how we are treated by the lecturers in this course”.

The evaluation of the project involved gathering information from a variety of sources, course evaluations, student results, student reviews of the process including the bus incident and self assessments of their projects against a predefined marking schedule, resulting in a combination of quantitative and qualitative data analysis. As the authors noted, with only ten groups participating in the study, a detailed statistical evaluation of the results was not possible. Nonetheless student performance on the course and their feedback regarding the course compared favourably with results from the prior year’s iteration (without ROBAB), with the majority of students in favour of repeating the exercise and 50% of them adding the condition that next year the ROBAB should hit all groups. Based upon this analysis and student comments from the other information sources, the first goal of the project was achieved - namely to replicate the Surendran & Young (2001) study about the positive effects of swapping projects.

The second goal (degree to which this was consistent with the empowering paradigm) required a different form of analysis, and adoption of a more critical reflective style. Results were analysed in terms of initial outcomes, and mid project responses compared to final responses. The initial outcomes demonstrated variously anger, enthusiasm and confusion amongst the students and some concerns about the unfairness of only some of the groups being hit by the bus. The unaffected groups were grateful and expressed relief. During the mid-project logical design phase, groups had some negative responses to the workload of making sense of the foreign group’s documentation, and some positive responses based upon the learning gained from seeing another group’s material. They also struggled with their attachment to their own design and becoming motivated about the new material they had inherited. Even the unaffected groups reported some loss of enthusiasm. In the final responses students’ opinions of the bus crash incident mellowed, and most came to see the value of documentation throughout the development process. A general finding appeared to be that the change had overall little impact on the final outcome of the project, with marks for the course following a relatively traditional pattern.

What was the impact of the bus crash on the course’s conformity with the empowering paradigm? While not specifically identified in the paper as a methodological framework, a form of dialectic analysis was applied (i.e. A current situation or *thesis* is compared with an opposing or *antithetical* situation, and as the contradictions are resolved a *synthesis* is derived representing the result of the analytical process). A more formal model of this process can be found in Myers (1995) under the framework of *dialectical hermeneutics*.

In this case the issue was approached by framing and reflecting upon a critical question: does the control imposed by the lecturer and consequent loss of ownership of the project by the students outweigh the benefits of swapping? At first glance the tenets of table 4 above have been violated, with ownership of the process and

choices reverting to the lecturer, and students being cast as victims of imposed circumstances. Students certainly voiced concerns over how they would be assessed and whether they would lose marks as a result of this perceived disruption in their learning. However the empowerment model does not preclude challenge, and expects that students will be actively engaged in meaningful teacher facilitated experiences.

Yet in creating a challenging situation, while the teacher may be empowering the students to achieve, students do not always immediately like things that threaten their passivity, so this may occasion some discomfort. It has been argued that personal control is a prerequisite for empowerment (Harris, 1994), and in this experience ROBAB students initially perceived a loss of self-control, but soon realized they could take charge of the situation, did have scope to exercise control over the remainder of their project, and gained enjoyment from the process. So it was argued that while the locus of control dislocates for a time it quickly returns and the overall feeling towards the course is positive.

By contrast the students who did not swap had their ownership removed by the threat of swapping but did not come to realize the benefits. Thus the adoption of this approach was seen to have imposed a phase of discomfort on the ROBAB groups, through which challenge they had emerged with an overall sense of achievement and a positive experience. By contrast those who had not had the benefit of the ROBAB challenge while initially relieved at being left alone, ended up overall less satisfied and less empowered from the experience.

Thus it can be seen that applying critical enquiry as a research approach into the effectiveness of an intervention in Computing Education involves a wide ranging form of analysis, involving the roles, actions and beliefs of the participants, the specific forms of data supporting that enquiry, and the linkages between the institutional and social forces that may constrain or prescribe the activities of the actors. Critical enquiry is of necessity holistic in its nature, and the tests for rigour in enquiry differ from those accepted in the classical science tradition.

Women Taking Positions within Computer Science?

In this case from the U.K., using feminist critiques of science, Stepulevage & Plumeridge (1998) analyse aspects of a computer science curriculum in an English “new” University, to show how in this context “Computer Science remains firmly situated within the domain of masculinist modern Western science” (ibid.). This study rejects what the authors consider the typical “gendered constructions” of much research into women in science, based upon a universality regarding women’s positioning and the dichotomy between the hard logic-based approach and a soft context based one. This dichotomy which associates the *concrete and contextual* with women and the *abstract and logical* with men, is regarded by such researchers as contributing to women’s exclusion from scientific domains.

In this study the authors deal more directly with how issues of power inform the positioning of women and men in CS education. Refuting the notion of their *identity as women* being the key problematic for the success of women in computing, the study argues that their *standpoint as women* provides a more

illuminating framework for analysis. This concept of *standpoint* derives from the work of Collins (1991) in her work on black feminist thought and situated knowledges. *Standpoint* for this study assumes that women may have a common experience of subjugation, but each brings her own perspective to situations, so that self, community and society are seen through a personally shaped lens. “However common experience of oppression ‘in no way guarantees that such a consciousness will develop among all women or that it will be articulated as such by a group...’” (Stepulevage & Plumeridge, 1998).

In this study the women participants were self-defining members of a minority (female computing students, representing some 24% of the computing student body), gaining entry to a body of knowledge in computer science. The study explores how “through their common experience of systematic exclusion from the enterprise of creating science and of subjugation as women that these women’s standpoints can be identified”. It is argued that this experience of exclusion or subjugation “enables them to engage with the rules in various ways, the tutor by attempting to integrate practice and abstraction, the students by developing alternatives to the given rules” (Ibid.).

In their analysis the authors investigate the *social construction* of a data structures course, to highlight the mutual construction of gender and computing within it. The method aimed to “unpack” this construction through a study of the course documentation, information on student backgrounds and outcomes, in-depth interviews with staff and students, and observations in both lectures and seminars. Thus the research method is a form of “deconstruction”, an analytical technique originating in literary criticism with writers such as Jacques Derrida (1973) the French postmodern theorist. For Beath & Orlikowski (1994), “deconstruction of a document reveals the dependence of that text upon taken-for-granted assumptions that may suppress, distort, marginalize or exclude certain ways of thinking”. A review of how to apply the techniques of deconstruction in research, can be found in the study by Beath & Orlikowski (1994) in which they deconstruct the *user - developer relationship* in information systems development.

In this analysis of women in computer science, the authors review feminist critiques of western science whereby science itself has been seen as a “masculinist rational practice”, in which “the discourse of what is referred to as modern science remains firmly rooted in claims of ideological purity, neutrality and universality” (Stepulevage & Plumeridge, 1998). In this context then, women in computer science are inherently “outsiders” operating within a masculine domain. Adopting Collins’ (1991) conceptualization of the ‘outsider/within’, these women students are then “outsiders in the enterprise of knowledge creation”.

In a deconstruction of the epistemology of science by Harding (1986) three ‘dogmas of science’ are exposed, as a useful tool for the analysis of computer science. She cites these as: “science as sacred; physics as the paradigm of science”; and ‘pure mathematics’ as value-free”.

In the first dogma science is seen as a story of creation that does not need to justify itself, and seen to act as a god’s eye view rather than acknowledge that it works from a specific location, in a form of ‘god-trick’ producing, appropriating and ordering all difference. Science defends this position by

asserting its separateness from society, with scientific facts distinct from social values.

In the second dogma with physics as the paradigm of science, the value-neutrality of physics is explored. In physics “the subject matter studied has been reduced to a simpler form and isolated from social constraints, i.e. the problematics of the everyday world, through the process of abstraction. The concepts and hypotheses of physics therefore, deny a need for social interpretation and explanations...There is no material context in which to frame a WHY question” (Stepulevage & Plumeridge, 1998).

The third dogma of science, wherein mathematical expressions are value-free, is shown to generate a form of purported neutrality through the reductionism necessitated by the experimental method, and the mathematical ‘purity’ derived from separating abstraction from reality, while failing to notice the problematic of the difficulty of reintegrating what is experimented upon back into its more complex social source. This separation of the pure from the applied is said to allow the pure the privilege of ‘god-tricks’, whereby the concrete products resulting from the discovery and development of algorithms can exist outside the domain of computer science and there is no need for critical self-reflection, a process argued to be missing from scientific education.

Armed with this set of tools the authors then proceed to analyse the construction of computer science in the experiences of the tutors and students in a data structures course. The four images relating to computer science in the University prospectus are analysed, and it is noted that the text used to represent computer science students visually establishes “white’ and ‘male’ as dominant. The photographs “forecast the potential enjoyment of abstract thought by white men, and the access to computers gained by white women and black men” (ibid.). Black women are absent, a construction consistent with the exclusion of black women from science. The representation of the one white woman, with her personal story, helps construct the ‘woman student’ as exceptional, someone very determined and willing to travel to get where she wanted.

In the interviews with students and tutors on the course, the logical nature of the thinking required in computer science was commented upon. Two men students observed that ‘you have to be fairly logical minded’ while a woman student observed that “you have to familiarize yourself with the way tutors think, how they operate’. Similarly in discussing why there were fewer women students, the tutors mentioned computer science being seen as male dominated because it was perceived as technical or a science, and the women observed that up until very recently computing was not an area for women at all, because it was safe to conform to the norm of what has gone before, and also noted that women had to work harder to prove themselves more.

The authors’ analysis of this difference, exposes the men as insiders aware of the rules, the women as outsiders needing to learn them. The study proceeds to explore the style of programming, by analysing the tutors beliefs, with the male tutor’s

description situating programming within a paradigm of rule following and using a proven method. The gendering of programming is argued as evident in that the context-fitting aspects of developing a program for direct use by people, e.g. acceptance testing, documentation and consideration of the software lifecycle are not considered relevant to this programming unit. A distinction was drawn between the male tutor's approach to teaching programming through abstraction as consistent with a scientific discourse, and the female tutor's standpoint, which emphasized the building of confidence through practice and understanding of the rules, a stance more consistent with a feminist epistemology, valuing knowledge gained through experience.

These insights have been developed based upon questioning not what is it about women and women's lives that have kept them from doing science, but what is it about science? The use of critical enquiry as a research perspective has enabled a different set of questions to be asked, a different form of analysis to be conducted, and as a consequence a new and more wide ranging set of insights to be generated into a set of critical issues in CS education.

Critical Enquiry In Computer Science Education

As noted above, critical enquiry is a relatively unusual research approach within CS education, largely because it adopts a rather different value position, and the above cases represent a few of the known studies. Other relevant work is summarized briefly below, but this collection should be viewed as representative of a rather dispersed literature rather than exhaustive. As an indicator of the paucity of research using this paradigm in CS education, a journal search of the ISI Web Of Science citation indices (ISI, 2002) returned 369 citations for "critical theory", 32 for "critical theory and education" and no citations for "critical theory and computer science". A slightly better ratio resulted from a search of the ACM digital library, returning 56 citations for "critical theory" and 17 for "critical theory and computer science", but of the latter few have any educational focus, some would be considered writing within the Information Systems domain, and some apply a form of literary criticism in their argument. A search of the ERIC (ERIC, 2002) educational database likewise returned 165 entries for "critical theory and education", and no entries for "critical theory and computer science".

In spite of this paucity some articles in addition to the cases profiled here can be identified, but ranging across a diversity of countries and discipline sources. Submissions based upon this paradigm tend to find greater acceptance in education, education technology or information systems outlets. A few examples of relevant work are briefly profiled below, including selected publications from the author's own work.

Selected examples of the use of critical enquiry in CS education

A first group of writings by the author (Clear, 2001a, 2001b, 2002b, 2002c) explore the issues of power imbalances in the teacher/student relationship, the increase of consumerism in the tertiary education context, the consequential impact on tertiary

education and the role of public higher education. The role of Information Technology in education is investigated, as a positive force for transforming the learning experience, reducing power differentials, or at least making them explicit through joint enquiry; or as a negative force furthering these consumerist tendencies, and encouraging passive and receptive student roles.

In a second group of writings (Clear, 1999d, 2003, Clear & Young, 2001, 2002) the authors investigate the research process itself, in the New Zealand higher education context, with particular emphasis upon computing in the Polytechnic and 'new' University sectors. They explore the construction of research itself using a deconstructive form of discourse analysis investigating power/knowledge in the research process. They investigate the barriers to new researchers, and critique changes in Government policy, which threaten to undermine the funding base supporting the linkages between research, teaching and practice in the computing discipline. The beliefs of new computing researchers in this sector are explored. The research is conducted through a critical and practical action research programme aiming to increase the research capabilities of new degree teachers (often from an IT practitioner rather than a research background). The research itself has been used as a means of modeling a critical research paradigm within a series of workshops conducted for new researchers within the sector.

In a third study Mann & Buissink Smith (2001) applied Robinson's (1994) empowering model of education to four undergraduate classes on the Bachelor of Information Technology at Otago Polytechnic, software engineering, databases, information systems management and the capstone project. Quantitative and qualitative forms of data were analysed, and the results shown to compare favourably with the characteristics of Robinson's empowerment model of education, suggesting that this mode of pedagogy had indeed been achieved in the courses.

In a UK Based study Dawson & Newman (2002) argue "empowerment is at least as important as knowledge acquisition and that IT is an ideal vehicle to empower people studying a variety of subjects at different educational levels". Given the volatility of the IT discipline they argue that the most useful attribute they can give their students is the confidence to find their own solutions to a given IT problem, and to cope with the unexpected in an IT context. While this notion of empowerment is not specifically grounded in, or referenced to, critical theory, a model of teaching and learning involving empowerment of students does at least demonstrate consistent aims. They argue that an experiential learning strategy, based upon project work supports an empowerment strategy. Four case studies are reviewed, a software engineering style undergraduate course, a workplace learning context for new graduates, a systems engineering sequence in a degree programme, and a high school programme for disruptive children using IT as an intervention to improve behaviour and learning outcomes. The authors argue the success of their empowerment approach, which they consider to be based upon an interpretivist philosophy, rather than a positivist one. While this categorization omits the critical evaluative paradigm, the goal of teaching the students "to learn how to learn" is nonetheless consistent with an emancipatory or critical philosophy.

In another work Alexander from an American University (2002) applies Habermas' (1984) theory of communicative action to a study in which student teams in a first year information systems cohort of 1600 were offered three different

options for completing their work, including working as classroom based teams, face-to-face independent groups or virtual teams collaborating via email. Using an action research method, questionnaires and observation, including recorded face-to-face conversations, were used to collect data, which were then analysed against the forms of communicative action proposed in the Habermas model. Findings of the study were mixed, with varying levels of communication arising, a surprising lack of interest in adopting the virtual group mode of study, relatively high non participation rates in the virtual groups, clear issues related to students' maturity and as a residential university, limited student need to study in this mode, but some degree of success in maintaining a permanent record of group activity.

In a US based ethnographic study Barker et al., (2002) immersed themselves in the learning environment of two different IT programmes, one a traditional computer science major and the other a technology arts & media programme. In the process of observing ten courses over a one year period the researchers compiled 648 pages of fieldnotes recording: number of students attending, sex and appearance, physical layout of classrooms and seating arrangements; and descriptions of interactions (student-student and student –instructor) and those interacting (male/female and major). The researchers then applied content analysis to categorize the data into patterns and themes. From this analysis in relation to the computer science courses, two categories arose which were: an impersonal environment and guarded behaviour; and an informal student hierarchy. These factors contributed to the creation of a defensive social climate in which the impersonal classroom climate communicated rejection rather than acceptance of students and the informal student hierarchy stemmed from communication emphasising superiority rather than equality, generating a competitive learning environment in which students are at risk of criticism, rather than a safer environment in which students can make mistakes and learn.

Conclusion

In conclusion it can be seen that critical enquiry is a research orientation, supported by a wide repertoire of methods, which can be used in diverse contexts relevant to CS education research. A set of new, holistic and frequently challenging questions can be addressed using critical enquiry. A deeper form of enquiry into power relations within the learning environment, and into the innate learning culture within a computer science context can be achieved by conducting research in a mode of critical enquiry. The findings from such research may spur us to seriously rethink the way in which the discipline is taught. This is an inherently challenging task, requiring considerable self-critical reflection, given the implicit and deeply rooted nature of beliefs in the computer science discipline and the associated teaching and learning cultures. Then of course, having decided that a change were warranted, the process of achieving that across the whole CS education teaching community would require another approach altogether. A critically informed community development and change framework such as critical action research might provide such a research model. But the inherent challenges of critical research present themselves when we

consider how we might really engage the CS education community to effect meaningful change.

References

- Adam, A. (1996). Constructions of Gender in the History of Artificial Intelligence. *IEEE Annals of the History of Computing*, 18(3), 47-53.
- Adam, A. (2002). Guest Editorial: Special Issue on Gender and IS. *Information Technology and People*, 15(2), 1-4.
- Alexander, P. (2002). *Teamwork, Time, Trust and Information*. Paper presented at the 2002 Annual Research Conference of the South African Institute of Computer Scientists and information Technologists on Enablement Through Information Technology, Port Elizabeth.
- Almstrum, V., Dale, N., Berglund, A., Granger, M., Little, J. C., Miller, D., et al. (1996). *Evaluation: turning technology from toy to tool. Report of the working group on Evaluation*. Paper presented at the Integrating Technology into Computer Science Education Conference, Barcelona, Spain.
- Apple, M. (1979). *Ideology and Curriculum*. London: Routledge and Kegan Paul.
- Apple, M. (1983). *Education and Power*. London: Routledge and Kegan Paul.
- Apple, M. (1986). *Teachers and Texts: A Political Economy of Class and Gender Relations in Education*. New York and London: Routledge.
- Apple, M. (1993). *Official Knowledge: Democratic Education in a Conservative Age*. New York and London: Routledge and Kegan Paul.
- Bain, J. (1999). Introduction (to the special Issue on Evaluation). *Higher Education Research & Development*, 18(2), 165-172.
- Barker, L., Garvin-Doxas, R., & Jackson, M. (2002, March). *Defensive Climate in the Computer Science Classroom*. Paper presented at the Thirty Third SIGCSE Technical Symposium on Computer Science Education, Northern Kentucky.
- Beath, C., & Orlikowski, W. (1994). The Contradictory Structure of Systems Development Methodologies: Deconstructing the IS-User Relationship in Information Engineering. *Information Systems Research*, 5(4), 350-377.
- Billings, D. (2003). Did they Fail or were they Pushed? Student Retention and Success Initiatives in Tertiary Education. *NZ Journal of Applied Computing & IT*, 7(1), 17 - 22.
- Bishop, R. (1996). *Collaborative Research Stories; Whakawhanaumatanga*. Palmerston North: Dunmore Press.
- Brocklesby, J., & Cummings, S. (1996). Foucault plays Habermas: an alternative underpinning for critical systems thinking. *Journal of the Operational Research Society*, 47(6), 741- 754.
- Brooke, C. (2002a). Editorial: Critical research in information systems: issue 1. *Journal of Information Technology*, 17(1), 45-47.
- Brooke, C. (2002b). Editorial: Critical research in information systems: issue 2. *Journal of Information Technology*, 17(4), 179 -183.
- Browne, A. (2000). The Potential Contributions of Critical Social Theory to Nursing Science. *Canadian Journal of Nursing Research*, 32(2), 35-55.
- Camp, T. (Ed.). (2002). *Special Issue Women and Computing* (Vol. 34). New York: ACM.
- Campbell, J., & Bunting, S. (1991). Voices and paradigms: Perspectives on critical and feminist theory in nursing. *Advances in Nursing Science*, 13(3), 1-15.
- Carr, W., & Kemmis, S. (1983). *Becoming Critical: Knowing Through Action Research*. Melbourne: Deakin University press.
- Carspecken, P. (1996). *Critical Ethnography in Educational Research*. New York: Routledge.
- Chamberlain, B., & Hope, B. (2003). *Integrating international students into computing classes: issues and strategies*. Paper presented at the 16th Annual NACCQ Conference, Palmerston North, New Zealand.
- Chell, E. (1998). Critical Incident Technique. In G. Symon & C. Cassell (Eds.), *Qualitative Methods and Analysis in Organisational Research*. London: Sage.

- Christie, A. (1997). Using E-mail Within a Classroom Based On Feminist Pedagogy. *Journal of Research on Computing in Education*, 30(2), 146-176.
- Clear, T. (1998, 17-21 August). *A Generic Collaborative Database - Part of a strategy to internationalise the curriculum and develop teamwork and communication capabilities*. Paper presented at the *The 3rd Annual Conference On Integrating Technology Into Computer Science - ITICSE'98*, Dublin City University Ireland.
- Clear, T. (1999a, Jun 27 - Jul 1). *A Collaborative Learning Trial between New Zealand and Sweden - Using Lotus Notes Domino in Teaching the Concepts of Human Computer Interaction*. Paper presented at the *The 4th Annual Conference On Innovation & Technology In Computer Science Education*, Cracow Poland.
- Clear, T. (1999b, Jun 19-24). *International Collaborative Learning - The Facilitation Process*. Paper presented at the *ED-MEDIA '99 - World Conference on Educational Multimedia, Hypermedia and Telecommunications*, Seattle, Washington.
- Clear, T. (1999c). "Eating our seed corn" or restricting crop diversity? *SIGCSE Bulletin*, 31, 15-16.
- Clear, T. (1999d). A Critical Perspective On Research In New Zealand Polytechnics - Polysyllaby In The Polytechnic Sector. In G. Muriwai (Ed.), *Business Performance Research And Development Centre -Working Paper Series* (Vol. 1;1, pp. 1-22). Auckland: Faculty of Business, Auckland University of Technology.
- Clear, T. (2000). *Developing and Implementing a Groupware Application to Support International Collaborative Learning*. Unpublished M. Phil., Auckland University, Auckland.
- Clear, T. (2001a, June 2001). E-Learning to Whose Agenda? The Discourse of Enterprise vs. the Discourse of Community. *OLS News*, 39-40.
- Clear, T. (2001b). Using Web Based Groupware for Active Student Feedback in the Learning Environment. *NZ Journal of Applied Computing & IT*, 5(1), 14 - 18.
- Clear, T. (2001c). Research Paradigms and the Nature of Meaning and Truth. *SIGCSE Bulletin*, 33, 9-10.
- Clear, T. (2002a). *Avatars in Cyberspace - A Java 3D Application to Support Performance of Virtual Groups*. Paper presented at the *Innovation and Technology in Computer Science Education*, Aarhus, Denmark.
- Clear, T. (2002b). E-Learning or e-Lemmings? Who pipes the tune? *CSS Journal (Computers in the Social Studies)*, 10(2), 1-7.
- Clear, T. (2002c). E-Learning: A Vehicle for E-Transformation or Trojan Horse for Enterprise? Revisiting the Role of Public Higher Education Institutions. *International Journal on E-Learning*, 1(4), 15-21.
- Clear, T. (2003). TEAC Research Funding Proposals Considered Harmful: ICT Research at Risk. *NZ Journal of Applied Computing and IT*, 7, 23-28.
- Clear, T., & Daniels, M. (2000, Oct 18-21). *Using Groupware For International Collaborative Learning*. Paper presented at the *The 30th American Society for Engineering Education/Institute of Electrical and Electronics Engineers Frontiers in Education Conference*, Kansas, Missouri.
- Clear, T., & Daniels, M. (2001, June 25 - June 27). *A Cybericebreaker for an Effective Virtual Group?* Paper presented at the *The 6th Annual Conference On Innovation and Technology In Computer Science Education (ITiCSE)*, University of Canterbury, Kent.
- Clear, T., & Young, A. (2001, 26-27 November). *Developing Novice Researchers' Understandings of Research*. Paper presented at the *Innovations and Links: Research Management and Development & Postgraduate Education Conference*. [Online]. Available: <http://www.aut.ac.nz/conferences/innovation/papersthemeone/clearpaperone.pdf> [3 October 2002]. Auckland University of Technology, Auckland.
- Clear, T., & Young, A. (2002). Met a Researcher? Research Paradigms Among Those New to Research. *NZ Journal of Applied Computing and IT*, 6(1), 18-25.
- Collins, P. (1991). *Black Feminist Thought: knowledge, consciousness, and the politics of empowerment*. New York: Routledge, Chapman & Hall Inc.
- Cukier, W., Shortt, D., & Devine, I. (2002). Gender and Information Technology: Implications of Definitions. *SIGCSE Bulletin*, 34(2), 142 -148.

- Davies, L., & Mitchell, G. (1994). The Dual Nature of the Impact of IT on Organizational Transformations. In R. Baskerville, S. Smithson, O. Ngwengyama & J. DeGross (Eds.), *Transforming Organisations with Information Technology*. North Holland: Elsevier Science IFIP.
- Dawson, R., & Newman, I. (2002). Empowerment in IT Education. *Journal of Information Technology Education*, 1(2), 125 - 141.
- Derrida, J. (1973). *Speech and Phenomenon*. Evanston, Illinois: Northwestern University Press.
- Duffy, M. (1985). A critique of research: a feminist perspective. *Health Care for Women International*, 6, 341-352.
- Elden, M., & Chisholm, R. (1993). Emerging Varieties of Action Research: Introduction to the Special Issue. *Human Relations*, 46(2), 121-142.
- ERIC. (2002). *ERIC Database*. Retrieved Nov 5, 2002, from <http://www.askeric.org/Eric/>
- Estrin, T. (1996). Women's Studies and Computer Science: Their Intersection. *IEEE Annals of the History of Computing*, 18(3), 43-46.
- Flood, R., & Ulrich, W. (1991). Conversations on Critical Systems Thinking. In R. Flood & M. Jackson (Eds.), *Critical Systems Thinking*. Chichester: John Wiley.
- Foucault, M. (Ed.). (1980). *Power/Knowledge Selected Interviews and Other Writings 1972 - 1977*. New York: Pantheon.
- Glass, N., & Walter, R. (1998). Creating a safe environment to talk about sexuality: Nursing educational research as the empowering strategy. *The Australian Electronic Journal of Nursing Education*, 3(2), 1-15.
- Gur-Ze'ev, I. (1999). *Feminism, Education and Critical Theory*. Retrieved 5 Nov, 2002, from http://construct.haifa.ac.il/~ilangz/femminism_education_and_critical_theory.html
- Habermas, J. (1972). *Knowledge and Human Interests, Theory and Practice, Communication and the Evolution of Society* (J. Shapiro, Trans.). London: Heinemann.
- Habermas, J. (1984). *The theory of communicative action (Vol 1) reason and the rationalisation of society* (T. McCarthy, Trans. Vol. 1). Boston: Beacon Press.
- Habermas, J. (1989). Social Action and Rationality. In S. Seidman (Ed.), *Jurgen Habermas on Society and Politics: A Reader*. Boston: Beacon Press.
- Harding, S. (1986). *The Science Question In Feminism*. New York: Cornell University.
- Harris, K. (1994). *Teachers: constructing the future*. London: Falmer.
- Hedges, W. (1997). *Timeline of Major Critical Theories in US*. Retrieved 5 Nov, 2002, from <http://www.sou.edu/english/IDTC/timeline/uslit.htm>
- Held, D. (1980). *Introduction to Critical Theory*. Berkeley: UCLA Press.
- Hirschheim, R., & Klein, H. (1989). Four Paradigms of Information Systems Development. *Communications of the ACM*, 32(10), 1199-1216.
- Horsburgh, M. (1996). *Quality, Quality Audit and Where are we going?* (Unpublished discussion paper for academic board). Auckland: Auckland University of Technology.
- Howcroft, D., & Truex, D. (2001). Special Issue on Analysis of ERP Systems: The Macro Level. *The DATABASE for Advances in Information Systems*, 32(4).
- Howcroft, D., & Truex, D. (2002). Special Issue on Analysis of ERP Systems: The Micro Level. *The DATABASE for Advances in Information Systems*, 33(1).
- ISI. (2002). *ISI Web Of Science*. Retrieved 5 Nov, 2002, from <http://www.isinet.com/isi/products/citation/wos/>
- Jennings, L., & Graham, P. (1996). Exposing Discourses Through Action Research. In O. Zuber-Skerrit (Ed.), *New Directions in Action Research* (pp. 49-65). London: Falmer Press.
- Kaminski, J. (2002, 6 Aug 2002). *Nursing Informatics, Section 7: WWWsites, Humanism - Critical social theory Sites*. Retrieved 5 Nov, 2002, from <http://www.nursing-informatics.com/kwantlen/wwwsites13.html>
- King, K. (1994). What Counts as Theory? In K. King (Ed.), *Theory in its Feminist Travels* (pp. 1-54). Bloomington and Indianapolis: Indiana University Press.
- Klein, H., & Myers, M. (1999). A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly*, 23(1), 67 - 93.
- Kuhn, S., & Muller, M. (1993). Introduction to the Special Issue on Participatory Design. *Communications of the ACM*, 36(4), 26-28.

- Kuhn, T. (1962). *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.
- Mann, S., & Buissink-Smith, N. (2001). What the Students Learn: Learning through Empowerment. *NZ Journal of Applied Computing & IT*, 5(2), 35-41.
- McKay, J., & Marshall, P. (1999). *2x6=12, or Does it Equal Action Research?* Paper presented at the Australasian Conference on Information Systems, Wellington.
- McKay, J., & Marshall, P. (2001). The dual imperatives of action research. *Information Technology and People*, 14(1), 46-59.
- McKernan, J. (1991). *Curriculum Action Research*. London: Kogan Page.
- Melrose, M. (1996). Got a Philosophical Match? Does it Matter? In O. Zuber-Skerrit (Ed.), *New Directions in Action Research* (pp. 49-65). London: Falmer Press.
- Melrose, M. (2001). Maximising the Rigour of Action Research? Why Would You Want To? How Could You? *Field Methods*, 13(2), 160 -180.
- Mill, J., Allen, M., & Morrow, R. (2001). Critical Theory: Critical Methodology to Disciplinary Foundations in Nursing. *Canadian Journal of Nursing Research*, 33(2), 109-127.
- Myers, M. (1995). Dialectical hermeneutics: a theoretical framework for the implementation of information systems. *Information Systems Journal*, 5(1), 51-70.
- Myers, M. (2000). *Qualitative Research in Information Systems*. Retrieved June 16, 2000, from <http://www.auckland.ac.nz/msis/isworld.html>
- Myers, M., & Young, L. (1997). Hidden Agendas, Power and Managerial Assumptions in Information Systems Development. *Information Technology and People*, 10(3), 224 - 240.
- O'Neill, M. (1996). Prostitution, Feminism and Critical Praxis: profession prostitute? . [Online]. Available: http://www.staffs.sc.uk/schools/humanities_and_soc_sciences/sociology/level3/prost3.htm [5 November 2002]. Staffordshire University. *Austrian Journal of Sociology*(Winter).
- Orlikowski, W., & Baroudi, J. (1991). Studying Information Technology in Organizations: Research Approaches and Assumptions. *Information Systems Research*, 2(1), 1 - 28.
- Reeves, T. (1997). Established and Emerging Evaluation Paradigms for Instructional Design. In C. Dills & A. Romiszowski (Eds.), *Instructional Development Paradigms* (Vol. 1, pp. 163-178). Englewood Cliffs, New Jersey: Educational Technology Publications.
- Robinson, H. (1994). *The ethnography of empowerment: the transformative power of classroom interaction*. Bristol: Falmer Press.
- Rocco, T. (1998). Deconstructing Privilege: An Examination of Privilege in Adult Education. *Adult Education Quarterly*, 48(3), 171-184.
- Smith, L., Mann, S., & Buissink-Smith, N. (2001). Crashing a Bus Full of Empowered Software Engineering Students. *NZ Journal of Applied Computing & IT*, 5(2), 69 -74.
- Stepulevage, L., & Plumeridge, S. (1998). Women Taking Positions Within Computer Science. *Gender and Education*, 10(3), 313 - 326.
- Surendran, K., & Young, F. (2001). Teaching Software Engineering in a Practical Way. *NZ Journal of Applied Computing & IT*, 5(2), 75 - 79.
- Susman, G., & Evered, R. (1978). An Assessment of the Merits of Scientific Action Research. *Administrative Science Quarterly*, 23(December), 583 - 603.
- Switala, K. (1999). *Feminist Critical Theory*. Retrieved 5 Nov, 2002, from <http://www.cddc.vt.edu/feminism/cr.html>
- Taket, A., & White, L. (1993). After OR: An Agenda for Postmodernism and Poststructuralism in OR. *Journal of the Operational Research Society*, 44(9), 867-881.
- White, L., & Taket, A. (1994). The Death of the Expert. *Journal of the Operational Research Society*, 45(7), 733-748.
- Wilson, F. (1997). The truth is out there: the search for emancipatory principles in information systems design. *Information Technology and People*, 10(3), 187-204.
- Yeaman, A. (1994). Special Issue: The Ethical Position of Educational Technology in Society. *Educational Technology*, 34(2).
- Zuber-Skerrit, O. (Ed.). (1996). *New Directions In Action Research*. London: Falmer Press.