

Embodying Our Values in Our Teaching Practices: Building Open and Critical Discourse through Computer Mediated Communication

DAVID R. GEELAN

*Department of Secondary Education
341 Education South, University of Alberta
Edmonton, Canada T6G 2G5
david.geelan@ualbereta.ca*

PETER C. TAYLOR

*Science and Mathematics Education Centre
Curtin University of Technology
GPO Box U1987
Perth Western Australia 6001
P.Taylorp@curtin.edu.au*

Computer mediated communication—including web pages, e-mail and web-based bulletin boards—was used to support the development of a cooperative learning community among students in a web-based distance education unit for practicing science and mathematics educators. The students lived in several Australian states and a number of Pacific Rim countries. They reported increased satisfaction with their studies, decreased feelings of isolation, and better support for their learning processes. This article describes the iterative processes of research and design involved in developing and refining the unit, which was based in a social constructivist/constructionist conception of teaching and learning, between 1997 and 1999. Issues and implications for others planning to develop web-based teaching units, including the time and energy commitment involved, and the challenges of credibly assessing online participation, are also considered.

We were attracted to using computer mediated communication (CMC) in a distance education (DE) professional development unit we taught for practising educators because it seemed to have the potential to support, in the DE context, some of the things we valued about the face to face teaching of similar courses. The more traditional, “paper and mail” distance education mode that had previously been the norm in this unit—students submitted three written assignments, after reading a structured set of papers, and the assignments were marked and returned to them—had led students to feel isolated and under-supported, and had failed to draw on the rich knowledge and experience of students to support one another’s learning. Further, because we were coming to understand our teaching using the dual referents of social constructivism and constructionism (Solomon, 1987; Tobin, 1990, 1993; Gergen, 1995; Steier, 1995), and because this perspective also formed part of the units we were teaching, the very individualistic nature of the students’ learning experiences seemed to be mismatched with both *what* we were teaching and *how* we were increasingly coming to believe we should be teaching.

The unit that is the focus of this article (we have taught one other unit in this web-based mode, as well as a large number in “paper and mail” distance education mode and face to face) is offered by the Science and Mathematics Education Centre (SMEC) at Curtin University of Technology in Perth, Western Australia. It forms part of the Master of Science (Science Education) and Master of Science (Mathematics Education) degrees at the university, and the unit itself is entitled “Curricula in Science, Mathematics and Technology Education.” Its unit number, and the shorthand name that is often used when talking about it, is “SMEC 612.” The students are practising classroom educators in Australia, New Zealand, South East Asia, and North America, studying in distance mode toward Masters degrees while continuing to teach. They come from all sectors of the educational community—public, private, and religious—and from the primary, secondary, and tertiary levels. This diverse student group has led us to try to develop the unit with a strong emphasis on students’ reflections on their own practices in their own context, and on developing new understandings in ways that are relevant to their classroom teaching.

The things we value about our face to face, on campus teaching—which we had begun to reflect on and attempt to improve in an organised way (Geelan, Taylor, & Day, 1996; Geelan, in press)—include rich interactions between students, openness to others’ ideas, a critical awareness of taken-for-granted beliefs and assumptions, and the willingness to suspend disbelief in new perspectives long enough to meaningfully engage with

them. We use the notions of “open and critical discourse” as a way of understanding these values and explaining them to our students:

The kind of discussion that we value is open, empathic and interested. In other words, rather than either simply discussing the technical requirements of the unit, or attempting to argue with and deconstruct the arguments of others, we believe the most productive kind of discussion occurs as we attempt to understand the ideas and perspectives of others, and to critically reflect on our *own* beliefs and knowledge in the light of those perspectives. (SMEC 612 Web Site)

This (developing) notion of open and critical discourse is considered in more detail below, and we present some evidence of the extent to which we are able to (a) embody these values in our own practices as unit developers/instructional designers and teachers and (b) support and encourage students in the unit to engage in open and critical discourse as an important part of their learning in the unit.

Some of the things we, and our students, found frustrating about the paper-and-mail mode of distance education included:

- the relative isolation of the students, in their widely separated cities and small towns,
- the fact that the amount of time taken for an assignment to be mailed to the university, passed on to a tutor, assessed and mailed back meant that feedback was often quite “stale” by the time it arrived, and
- the paucity of human interactions in a course that purported to help students learn about teaching, an activity that is defined by human interaction.

We also realised that our backgrounds as upper secondary school science and mathematics educators did not equip us with the contextual experience that would allow us to really understand the concerns of the, for example, generalist Year 4 teachers (teaching eight and nine year old students) and tertiary computing teachers in our classes. But other members of the class *did* have relevant background experiences, and a mode of communication that would allow this experience and knowledge to be shared seemed to us to have a lot of potential. And of course, the reverse is also true: it is valuable for secondary science teachers and Year 4 teachers and tertiary lecturers to “cross-pollinate” their experiences with those from different educational communities.

This article outlines three iterations (1997-1999) of an ongoing development, teaching and research cycle, which has been partially documented before

in conference presentations from our research group (Dawson, Taylor, Geelan, Fox, Herrmann, & Parker, 1999; Geelan, Taylor, Fox, Herrmann, Stapleton & Dawson, 1999; Herrmann, Fox, Taylor, Geelan, Dawson, Stapleton, & Parker, 1999; Stapleton, Taylor, Dawson, Geelan, Fox, Herrmann, & Parker, 1999; Taylor, Geelan, Dawson, & Stapleton, 1999a; Taylor, Dawson, Geelan, Stapleton, Fox, Herrmann, & Parker, 1999b; Taylor, Geelan, Fox, & Herrmann, 1997). This cycle began in 1996, when we first collaborated to put another unit—SMEC 501: Foundations and Issues in Science and Mathematics Education—on the World Wide Web (WWW or Web). In Semester Two, 1997 we first taught SMEC 612 on the Web, and each year since then we have extensively revised the unit, seeking to more fully embody our educational values in our teaching practices, and taught it again. In May 2000 we revised the unit yet again for 2000 (although the revisions are less fundamental than in previous years).

RESEARCH AND DESIGN APPROACH

Cal Swann (1999) of Curtin University's School of Design has discussed the relationship between the activities and phases of design and those of action research. He cited Otrun Zuber-Skerritt's (1992) description of action research as an iterative process in which researchers plan, act, observe, and reflect, then repeat the cycle. Swann continued:

The above cyclical approach is very familiar to designers as it bears a strong resemblance to the design process outlined earlier: problem – analysis – synthesis—evaluation....Design seldom takes place as a single flash of inspiration that resolves *all* the pieces in one go. It usually requires several cycles to review, amend, adapt and refine before the initial concept is worked out and the execution of a design solution can be made. (p. 6)

This project has taken on the nature of an ongoing design/action research cycle, in which each iteration of the unit is developed in the context of intensive, collaborative reflection on both (a) the ethical and pedagogical values we are attempting to embody in our teaching practices, and (b) the successes and failures of the previous iteration. This latter focus involves us in the hermeneutic phenomenological process of attempting to describe and understand our students' learning experiences in SMEC 612.

We have taken Max van Manen's (1990) "hermeneutic phenomenological" approach to human science as a key referent for this research project. Van Manen suggested that:

...when we raise questions, gather data, describe a phenomenon, and construct textual interpretations, we do so as researchers who stand in the world in a pedagogic way...pedagogy requires a phenomenological sensitivity to lived experience...a hermeneutic ability to make interpretive sense of the phenomena of the lifeworld...[and]...play with language in order to allow the research process of textual reflection to contribute to one's pedagogical thoughtfulness and tact. (1990, p. 1-2)

These three elements—(a) a phenomenological sensitivity to the lived experience of oneself and others, (b) the hermeneutic activity of interpreting and making sense of that experience, and (c) the semiotic/textual activity of representing both the lived experience and our interpretations in writing—comprise a research approach for human science in the service of teaching.

Van Manen (1991) saw “tact” or “thoughtfulness” (the terms seem to be used almost synonymously) as including both of the common senses of the word “thoughtful”—(a) a considerate, empathic regard for the needs and ideas of others, and (b) a propensity for critical reflection. To behave tactfully or thoughtfully toward others, he suggested, it is necessary to be thoughtful about our experiences and ideas. It is this idea of “thoughtfulness” that influenced Van Manen’s methods for conducting inquiry into pedagogic situations and practices. As teacher-researchers, our stance during the planning/action/reflection cycles of developing and teaching the unit was pedagogic. Our practices were not those of objective researchers whose purpose was to passively observe the activities of others and to attempt to make sense of them, but of teachers, educationally involved with professional educators in a learning context, attempting to richly understand that involvement in order to improve it. As such, thoughtfulness in both these senses was required. First, it was necessary that we were thoughtful and tactful toward students and colleagues in trying to understand what it would mean to improve our practices and their learning. That is, it was important that we made a sincere attempt at understanding their perspectives and understandings and expectations. Second, it was necessary for us to be critically reflective about our own assumptions, ideas and prejudices, and to be actively involved in reconstructing both our experiences in formal educational settings (as teachers and learners) and the rest of our beliefs and life history. This is an iterative process:

...pedagogy requires a reflective orientation to life... By thoughtfully reflecting on what I should have done, I decide in effect how I want to be. In other words, I infuse my being and my readiness to act with a certain thoughtfulness. And yet, how I am now as a teacher will not be clear until

I have had further opportunities to act in more appropriate ways. How I am as a teacher depends on what I do, on my possibilities for acting thoughtfully. But my possible actions do not magically arise, they depend on the thoughtfulness that I have been able to acquire in recollective reflection. (Van Manen, 1991, p. 116)

From Van Manen, then, we have taken not so much methodological prescriptions—particular modes of data collection and analysis and representation—but a stance for “being in the world.” Our concerns are pedagogical, rather than philosophical, psychological, or sociological, and the modes of inquiry that are appropriate for addressing these concerns are likewise pedagogical. We wish to suggest that disciplined, thoughtful, reflective inquiry that takes as its starting point ourselves and our current teaching practice, but acknowledges our quest to more fully embody our values in our practice, is the appropriate mode of inquiry for this study.

The combination of these two elements—the iterative design/action research cycle of planning, implementation, observation and reflection, and a hermeneutic/phenomenological approach to attempting to understand and improve the learning community in the unit—informs both the on-going process of developing, revising and teaching SMEC 612 and our research writing about that process (such as this article). The following sections outline important *referents* (mental models to which practice is referred) for our teaching/learning/research practices, then describe the development and teaching of the unit in 1997, 1998, and 1999. The final three sections of the article address respectively the issue of the time and energy commitments of web-based teaching, the challenges of assessing on-line participation, and the evidence we have used in this ongoing, iterative research and development process.

SOCIAL CONSTRUCTIVIST/CONSTRUCTIONIST TEACHING AND LEARNING

One important referent for our teaching in both face to face and distance education modes of teaching is *social constructivism* (Solomon, 1987; Taylor et al., 1997; Geelan, 1997). Constructivist theory (Steffe & Gale, 1995; Tobin, 1990, 1993) contributes to our understanding of learning as (a) a process of constructing new knowledge by reflecting on the viability of one’s existing knowledge in light of new experiences, and (b) a socially mediated process of negotiation of meaning amongst a community of learners. From critical theory (Habermas, 1987) comes a view of an empowered learner as one

who (a) seeks to understand others' understandings through an interest in open communication, and (b) reflects self-critically on the unconscious and shared beliefs and values that shape her routine social practices. Combining these perspectives yields a set of educational principles for empowering students through self-reflective critical thinking to develop deeply connected understandings (Belenky, Clinchy, Goldberger, & Tarule, 1986; Noddings, 1984) of their own beliefs and social actions. As educators, our aim is to enhance that learning process by providing enriched opportunities (using CMC) for intellectually and socially isolated students to engage in reflective discussions of the type that can occur in a university classroom setting.

Social *constructionism* (Gergen, 1995; Steier, 1995) is a complementary referent for us in understanding the teaching/learning processes occurring in the unit. This metaphor of mind differs in subtle but important ways from constructivism. From this epistemological perspective, mind is distributed in *dialogical space*. That is to say, knowledge is constructed and known through dialogue—through processes of speaking, listening, and interacting with others. This gives rise to the metaphor of learning as co-participation in discursive activities modelled *by experts*. Constructionist theorists argue that the constructivist metaphor of *mind as embodied* places too much emphasis on the individual thinker as the controller of knowledge construction, and fails to account for the extent to which knowledge claims arise and are tested within a *discourse community*. Student's learning experiences in the unit, therefore, come to be seen as the co-construction of a discourse, where the tone and focus of the discourse are modelled by the tutors, but all students co-participate in building and sharing new knowledge and practices.

OPEN AND CRITICAL DISCOURSE

Dawson and Taylor (1998) suggested that:

Open discourse enables students to assign language to their own ideas and to experience learning as a co-participatory activity (Tobin, 1997). In doing so, students have the opportunity to experience [learning] as a discursive activity in which value-laden knowledge claims are legitimated in accordance with canonical standards (Lemke, 1995; Roth, 1997). Open discourse is central to a classroom environment shaped by the referent of critical constructivism... (p. 325)

Open discourse is also about creating an environment in the classroom—or in this instance in the virtual classroom of the web-based unit (including

both bulletin board postings and e-mail messages)—that makes it safe for students to voice their opinions and take risks in discussing new ideas. Because personal and professional values are one important focus of the unit, this can be quite challenging: we are asking a group of strangers to be willing to discuss values that they hold as part of their professional self-image, and be willing to explore the implications of possible changes to these core values. Open discourse does not require a completely uncritical acceptance of all ideas and perspectives, but it *does* require every member of the learning community (tutor and students) to be willing to listen, to work hard to understand, and to support the clearer expression of one another's ideas. A number of strategies were used to encourage the development of open discourse in the unit, including modelling by the unit tutor, and explicit statements in the site. For example, in the Instructions page of the 1999 version of the unit, we said:

While we're all for passionate discussion and debate, please remember that we also want to foster a feeling of safety for all participants. If you disagree with someone, stick to the topic, don't attack the person, and choose your language carefully.

Remember that e-mail messages [and bulletin board postings] lack many of the body language cues of personal interaction, so that it can be difficult, for example, for the reader to detect irony. The use of smilies or emoticons can help make your message clearer.

Open discourse alone, while safe for the participants, can lead to a somewhat directionless discussion, since it involves only the attempt to clearly communicate our own perspectives and to understand the perspectives of others. Open discourse requires the use of empathy and imagination, and a willingness to listen carefully to both the text and subtext of others' messages. It is most powerful in developing an educative relationship (Habermas, 1987), however, when it is held in a dialectical tension with critical discourse.

In describing the use of critical discourse in secondary school science classrooms, Dawson and Taylor (1998) stated that:

Another type of discourse is central to a classroom shaped by the referent of critical constructivism: a critical discourse aimed at deconstructing repressive cultural myths that distort communicative relationships, particularly those which regulate the social reality of the science classroom... (p. 329)

Critical discourse involves making problematic, and critically reflecting upon, the taken-for-granted values, assumptions, social practices, and epistemologies that underpin learning practices, in the service of developing communicative relationships. That is to say, the essential purpose behind both open and critical discourse is the development of rich, complex, empathic and highly thoughtful (in both senses) relationships between those co-participating (Tobin, 1997) in a particular learning activity. Open discourse works toward making the environment safe, and clarifying communication, while critical discourse is intended to expand the sphere of possibility within which the discussion occurs, and to break down repressive myths or reified features of the cultural context within which the learning activity is developing. Students were encouraged to reflect seriously on which of the constraints they experienced in their teaching practices in their own classrooms at school, and in the virtual classroom in this unit, arose out of their own assumptions and beliefs or those of others, rather than out of genuinely non-negotiable environmental features. The dual emphasis—on students' practices as teachers in classrooms and as learners in the unit—allowed students to reflect on the issues from a variety of perspectives, as did comparing experiences and contexts with colleagues from different school sectors and age levels in different countries.

Burge (1994) lists four types of peer behaviour that are important for successful computer mediated learning:

1. Participation—giving alternative perspectives, showing the application of an idea, risking to publish tentative thoughts, and attending to the experience of others.
2. Response—giving constructive feedback, answering questions, not being repetitive, being responsible generally in small group work, complimenting peers, and engaging in the content of the messages.
3. Provision of affective feedback—use of a person's name, helping people belong, being patient... and providing a climate that is sustaining and confirming.
4. Short, focussed messaging. (Adapted from Burge, 1994, p. 30)

We would also identify these as being very important behaviours—and attitudes and dispositions—for the success of open and critical discourse in an online forum. We observed examples of both the fulfillment and the absence of each of these conditions, and the effect on the communicative actions of the class groups—some of these are discussed in the following description of each year's teaching and learning.

The four criteria that were used to assess students' contributions in the Discussion Room from 1998 forward (assessment strategies are discussed further) reflect these concerns with open and critical discourse. As outlined in the 1999 web site, they are:

To be consistent with the unit goals of *open discussion* and *critical reflection*, your contributions to the discussion will be assessed in accordance with four standards:

1. The Learning Goals and Assessment Criteria listed at the beginning of each Activity.
2. Openness, empathy and willingness to listen. This doesn't mean you can't challenge someone else's ideas, but you need to do this carefully, choosing your words, and in the context of a genuine effort to understand.
3. Critical reflection. We believe that it's more powerful from a learning perspective to thoughtfully challenge *our own* ideas and beliefs in critical reflection, rather than only to argue with others - the latter tends to just entrench us in our old ideas.
4. Minimum quantity. As noted above, we hope the discussion will be able to take off in interesting directions. The minimum requirement, though, is that you respond to each of the Discussion Activities, and also write at least one follow-up message to the responses of each of your study group partners.

The emphasis in critical reflection and critical discourse is perhaps closer to what is connoted by critique rather than criticism: an attempt to engage with ideas at a high level and to add value to the discussion through offering alternative interpretations and constructions, rather than a rejection of one perspective from within another, or an argumentative demolition of an opposing perspective.

DEVELOPING AN ONLINE UNIT FOR TEACHERS

As described previously, the development of the interactive web sites and associated teaching practices that constitute the online unit SMEC 612 was an iterative process, involving cycles of intense development activity, followed by a semester of teaching (with a large amount of disciplined reflection and discussion), then a retrospective reflection on the unit and its effects

on the learning of the students, leading into a new cycle of development, teaching and reflection.

The following descriptions of three versions of the SMEC 612 unit, and the design decisions that went into each, will make much more sense to readers who have seen the actual sites, including the Discussion Rooms. An index page at <http://www.curtin.edu.au/learn/unit/smec612/intro.htm> allows access to four iterations of the unit, from 1997 to 2000 (the <40 Notice Board messages from the 1997 course have unfortunately been lost in a computer crash), showing the progressions of style and approach described in the following sections, and we would urge readers to read this article in conjunction with those web sites.

1997—Drought

The initial online version of SMEC 612 was essentially just the paper and mail version of the unit developed as a web site by turning the word processor files into html files and placing them on a server. In order to foster student interactions we added a Notice Board, using the freeware CGI script `wwwboard` (written by Matt Wright—<http://www.worldwidemart.com/scripts/wwwboard.shtml>), however in this instance it was as an optional extra, with no activities based on the discussion formally included in the unit, and no proportion of the unit grade devoted to the discussion. The web site consists of three Modules corresponding to the three written assignments in the course, plus the Notice Board, a set of instructions for electronic communication and a rudimentary Resource Room where we posted links and documents of interest that we encountered in the course of the semester.

Perhaps predictably (in hindsight), our busy teacher-students tried the Notice Board, but did not devote a lot of time to it: we felt that the discussion was not particularly successful in this first trial. We had used the metaphor of ‘Discussion Room’ for this electronic bulletin board in the 1996 version of SMEC 501, but in other ways the approach had been similar, and the results, too, were similar—a few desultory social posts and a serious under-utilisation of the bulletin board. In the 1997 versions of both SMEC 501 and SMEC 612, we virtually threw our hands in the air and said “well, if you’ll only post a few messages and not interact, then Notice Board is a more appropriate title,” and left it at that.

Students recognised the relative paucity of messages in the Notice Board, but still stated that it had been valuable to them. Laura (all names used other than our own are pseudonyms) wrote:

I have not felt that I have had anything sufficiently important to contribute. While I may be quite chatty on a 1:1, I'm quiet in a larger group and especially if I don't know the people. I need to be more confident of what I am saying or be able to see the people's faces for an instant reaction. Apart from my guilt at not participating I have enjoyed having the [Notice Board] open. I at least know people's names and a little bit about everyone. It has stopped me feeling so isolated.

We really weren't satisfied with this result, however—for all the reasons discussed above, we saw a lot of potential in encouraging our students to interact more with one another and with us. We reasoned that busy people—and people who have been in the educational game a long time—will largely be looking at the unit in terms of 'where are the marks? what is rewarded?' This is understandable, both in terms of the time pressures our students were experiencing, and because the assessors (us) could reasonably be assumed to assign the marks to the things we valued and considered important about the course: "if there are no marks for participating in the discussion, then clearly the discussion is not very important!"

1998—Deluge

Our dissatisfaction with the level of interaction between the students in the 1997 course, and our realisation that this was at least in part attributable to the assessment structure of the unit, led to a quite dramatic revision of the unit for 1998. It was at this time in our experience of online teaching that a realisation that had been developing in our minds for some time—that online pedagogy is a qualitatively *different* activity compared to either face-to-face teaching or traditional distance education—was really able to be embodied in the electronic "artifacts" (the web site and the use of e-mail) produced to support our teaching. The three "modules" from the earlier versions of the unit were broken down into seven "Activities"; the term was chosen to highlight the (intended) active nature of students' learning experience in the unit. A number of extra pages were added to the site, increasing its complexity but also providing more support for students. These included a Unit Outline page and a page describing how students should contribute to the more structured discussion on the renamed "Discussion Room" bulletin board (which still used the *wwwboard* software). There were still three written assignments in the course, but these were now worth 25% of the unit grade each, for a total of 75%, with the remaining 25% of the grade coming from participation in the Discussion Room. For each of the seven Activities there

was a “Discussion Activity” question which students were asked to answer in a brief post to the Discussion Room. They were also required to respond to the posts of at least two other class members for each Discussion Activity.

For this iteration of the unit we used a number of small, loosely organized study groups of three students. Members of a group were often teaching in similar contexts in terms of student ages and subject areas, although often widely geographically separated. Students were encouraged to “get to know” their fellow group members more closely than the other students in the broader class group of around 12 students, and to respond to the Discussion Room messages of their group members. This approach was intended to further reduce the isolation of the students, and to lead to sustained conversations with a small group, rather than random comments thrown into the larger group. The use of study groups was seen as a successful strategy, but was modified slightly for the 1999 unit.

One interesting point was the change to the volume of posts to the Discussion Room, despite using the same software package and technological approach. From around 40 posts in 1997, the discussion expanded dramatically to over 500 posts in the 1998 version of the unit. We had officially required a total of about 21 postings from each student in the unit (i.e., one response to each Activity question plus two responses to the posts of other members of their study group for each of the seven Activities), however the average number of posts per student was over 50. We interpreted this result as suggesting that, once a certain “critical mass” of discussion is occurring, in this instance under the pressure of the proportion of the unit grade assigned for online participation, the discussion will take on a life of its own and become active and engaging for students. Because there was no mandate from the tutors, communicated through the assessment structure of the unit, to overcome any initial student resistance in the 1997 version of the unit, this critical mass was never attained, and the discussion fell short of achieving its potential.

With the benefit of hindsight, the workload demands placed on our students (and on us as tutors) by the 1998 unit were unrealistically high: we had essentially grafted the Discussion Room workload, which involved around 50 thoughtful posts for each student, directly on top of the three full size assignments in the existing unit. The seven Activities, one every two weeks, was also an incredibly unrelenting load for both students and tutors, with no nonteaching period scheduled in the semester. In revising the unit for 1999, one emphasis was developing a more appropriate workload, and one that more directly mirrored our developing perception of *how* students were actually learning in the unit, rather than simply the existing paper-and-mail models of distance education.

1999—Balance

In order to be able to develop a richer form of Discussion Room interaction, including the ability to categorize the discussion by purpose, in 1999 we chose to use a commercial software package called the *Ultimate Bulletin Board* from Madrona Park, Inc. (now Infopop Corporation—<http://www.ultimatebb.com>). This package brings all the messages in a particular topic into a single document, rather than requiring each post to be opened individually by clicking on a link, and allows for a better flow of discussion within a topic (although it may also limit the spontaneous thread splitting that can occur in a differently organised bulletin board).

It also allowed us to split the discussion into three separate forums entitled Activities, Social, and Technical. The Technical forum was intended to be a low volume list for dealing with the mechanics of both the unit and the web site: a place where students' questions about gaining access to the site and the discussion, as well as about the assessments and standards in the unit, could be discussed by students and answered by tutors and/or IT support people. The Social forum began the semester with a brief Introduction message from each student in the group, and was a place for general discussion about workloads, holidays, families or whatever students wanted to discuss with one another that was not directly related to the assigned work of the unit. This could also include more general and broader discussion of issues raised in the Activities forum. The Activities forum was the more 'formal' part of the unit. Only tutors could post new topics in this forum, and this generally involved creating a new topic thread for each of the two study groups (of five to six students each, for each of the five, reduced from seven, Discussion Activities).

We often used the metaphor of a school building when talking about the web site, and on this metaphor the Technical forum corresponds to a student choosing to visit the tutor in his/her office for counsel, advice, or help. The Social forum corresponds to casual discussion before and after class, or in the cafeteria, while the Activities forum corresponds to the actual classroom during class time. In the latter forum the 'teacher' retains more control of the discussion and activities than in the others. Students were also able to contact one another and the tutors privately by e-mail—perhaps analogous to a phone call or an informal chat in the school hallway.

The unit was reduced from seven Activities to five, as one way of addressing the work load for students, with the fifth Activity focusing on the preparation of a portfolio of material intended to represent students' learning in the unit. This portfolio was submitted to the tutor for assessment, either

electronically or by mail (and in one case on a CD-ROM!), and formed 40% of the unit grade. Participation in the five Discussion Activities formed the remaining 60% (up from 25%) of the grade. One reason that we had been reluctant previously to apportion a large part of the assessment to the online component of the course was that we were not sure how to credibly assess this kind of work: this issue is discussed further.

The study groups were larger in 1999, consisting of five or six students (the total class size was again around 12), and slightly more structured. (Incidentally, we also envisaged the use of study groups as one way of supporting the small group cohesion and feeling of connectedness within a very large class group. We hope to develop a similar unit for a class group of 60-100 students to test this application of the study groups strategy at some point in the future.) For each of the five Activities, one member of the study group took the role of leader. The leader for a particular discussion was not required to post an initial response to the discussion question, or to participate in the general discussion of the issue arising from the posts of the other members. Instead, he or she was asked to post a reflective summary of the ideas raised in the other posts, toward the end of the period set aside for that Activity. This led to an extra emphasis on listening actively, understanding and trying to fairly and clearly represent the perspectives of others, which in turn fostered open discourse. It also led the group leaders to reflect on the assumptions underlying the posts in the discussion, and sometimes to gently point these out in the course of their reflective syntheses of the discussion, fostering critical discourse.

The use of the study group leaders was also intended to reduce the time demands on the tutors: in 1998 students seem to have expected—and the tutors to some extent fostered that expectation—a very high level of responsiveness and involvement in the Discussion Room on the part of the tutors. So much so, that the comments of other class members seemed to be accorded less credence than those of the tutor, and the discussion became highly teacher-centered. The use of the study group leaders in the 1999 unit meant that this discussion-leading role was taken by peers rather than by the tutors, who were then freed from a very intensive and low level role responding to almost every post, and therefore had more time in which to read, reflect on, and manage the overall direction of the unit, address any perceived problems, and give more attention to the task of assessing the online discussion. The study groups led to a higher relative value being placed on the comments of peers, rather than students really listening only to the tutors.

Time and Energy Commitment

The revisions of the unit for 2000 are less dramatic, and deal with the educational content and conceptual tools of the unit, rather than the structure of the web site and Discussion Room or the assessment approach in the course. One issue with a development sequence like that described previously is the very large commitment of time and resources required to get the site and the unit to its present state. No doubt to some extent we reinvented the wheel, working in relative isolation from others developing web-based teaching and learning approaches. A challenge that we found, however, in searching the literature for approaches that might serve us, was that: (a) the literature about online teaching and learning is dauntingly immense, but that (b) much of it was irrelevant to the kind of deep, reflective learning, and open and critical discourse we wished to foster, since examples and approaches seemed to be strongly focused on content delivery, and (c) much of the literature tended toward triumphalist “technoboosterism” rather than realistically addressing the challenges, demands, and setbacks of developing and teaching online courses.

We argue that the process of developing our course essentially from scratch was a valuable one in terms of developing our own knowledge and skills, and causing us to reflect deeply and collaboratively on the kinds of values and pedagogical approaches that were appropriate to a new medium. But we also acknowledge that it places high barriers in front of those of our colleagues who would like to explore online teaching and learning but who are less comfortable with and/or less passionate about the relevant technologies. This project would likely not have gone ahead without the many hours we were willing to commit to developing the sites and the courses, and had we been unable to do most of the coding, setup, and maintenance ourselves.

Assessing Online Participation

We found it quite challenging to assess students’ online participation in discussions in the unit: this was a different activity, focused on a different form of discourse, compared to the more traditional model of assessing carefully prepared and well-referenced academic assignments. The online discussion was much more like a conversation, in that it was often responsive, unstructured, and less organised than most written representations of thoughts and ideas. We highly valued this flexibility and complexity, but

that did not make it any simpler to assign fair, credible grades to students' individual performances. The clash between our pedagogical and assessment practices and our commitment to a social constructivist/constructionist understanding of teaching and learning had been to some extent addressed through the interactive discussion, but it appeared again in the issue of assessment: if learning and the construction of knowledge are social processes in which students are coparticipants, is it even epistemologically feasible to assign individual grades?

We felt that the constraints imposed because of the unit's location within a degree-granting university course, and its use in parallel with other units, meant that we did have to assign grades to individual students, based on their participation in the online discussion. In earlier stages of our teaching together, we had tried to minimize the importance of assessment, since it was not a function that we valued highly. Our students corrected us on this point and required us to re-think our commitments: for these students, the unit is part of a masters degree that is instrumental toward promotion and employability, as well as valued for professional learning. In that context, they are highly motivated to receive high grades (and, as teachers, our students also often place a very high value on academic success as measured in assessment results). Given this value position on the part of our students, it was disingenuous and unfair of us to insist that marks aren't important: it was necessary for us to be open, honest, and clear about our assessment processes, but to be willing to change those processes so that the assessment correctly reflected the importance *to student learning* of particular activities, behaviours, and attitudes.

For Karen, one of our students in the 1998 unit, our valuing of flexibility and complexity, and our unwillingness to provide a highly detailed marking scheme in advance, was seen as something of a betrayal. She wrote:

Thanks for the comment about Assignment 1. Can I have a detailed copy of the criteria that you used to mark the assignment and a breakdown of my marks in the various assessed areas? I would give such feedback to any of my students and would like the same opportunity to "learn from my mistakes."

David responded:

I'm sorry, but I really can't provide that kind of breakdown. Both Peter and I marked the assignment, and we tend to use a more holistic and inter-subjective approach, rather than saying "5 marks for the introduction, 7 for the argument, 3 for references" and so on. We value flexibility

and creativity, and feel that a “closed” scheme like that can tend to close our minds to creative approaches. We each read the assignments and made notes and comments, then worked together to decide on the grades awarded.

Finally, all assessment in this unit is “redeemable”: if you are unhappy with the grade assigned, or think you can do better, you are welcome to take the feedback you have been given and incorporate it (as you put it above, to “learn from your mistakes”), then resubmit the assignment for a second assessment, from which you will receive a higher grade if the suggestions have been addressed.

Peter shared David’s understanding of our assessment regime in the unit:

That’s a terrifically good response to Karen. I very much like the emphasis on holism and intersubjectivity, and on redemption. I’m confident that our prespecification of learning goals and congruent assessment criteria are pedagogically sound, and allow us to grade assignments in the manner you outlined.

Karen replied:

Thank you for the comments re assign 1 and 2. If I was to say such things about marking of assignments to my Yr 12 students or their parents I would be in trouble re accountability of assessment. Never mind - I guess its worthwhile remembering, however, that no student can be expected to read the teachers mind when it comes to knowing exactly what is required.

We felt that we had specified the unit requirements and criteria very clearly ahead of time in the web site, and had not required students to “read our minds,” but that perception on our parts was clearly not shared by this student, who felt that we were being unaccountable in the level of detail provided in our assessments. We remained very much aware of this challenge in developing assessment criteria and approaches for students’ on-line participation in the 1999 version of the unit.

We chose to assess students’ online participation at two points during the semester, after activities one and two and three and four respectively (this approach evolved in response to student requests, since our initial intention had been to assess all participation at the end of the semester). We chose to use the four quality criteria we had specified for online messages in the Discussion Room as the basis for each assessment, but to also provide some written guidance for students in how their achievement could be improved as the unit proceeded. Rather than assign a numerical grade to each

criterion—since we were aware that our judgements of the discussion were intersubjective and insufficiently precise for a percentage or decimal scale—we chose to grade each criterion on a scale of Par, Good, and Excellent. Par meant that students had achieved at the minimum standard required, but had not exceeded this minimum in any way. (If students' participation was below par we would already have undertaken some remedial tutoring activity to lift the standard to at least par.) The following examples of feedback given to an excellent student and to a student who needed to improve in some areas:

Just to remind you of the system: I will grade your performance on a three point scale of Excellent, Good and Par, on each of the four assessment criteria for the unit. "Pa" just means exactly what would be expected, no more and no less, so to gain a score of "Good" or "Excellent" you need to be doing more and better than just the expected.

See the Discussion Activities page at:

<http://www.curtin.edu.au/learn/unit/smec612/standard.htm>

for the full forms of the criteria: I'll abbreviate them here for space reasons.

1. Learning Goals and Assessment Criteria. *Excellent*
2. Openness, empathy and willingness to listen. *Excellent*
3. Critical reflection. *Excellent*
4. Quantity. *Excellent*

Once again, excellent, thoughtful, interesting participation: and you've figured out the trick to keeping under half a page (lots of little posts instead of a couple of big ones)! Your summary for Activity Three was one of the best in the unit, because it didn't simply summarise but tried to carry the discussion and the ideas of the group members forward to the next level. Well done.

For another student:

1. Learning Goals and Assessment Criteria. *Good*
2. Openness, empathy and willingness to listen. *Good*
3. Critical reflection. *Good*
4. Quantity. *Par*

I've enjoyed your contributions, Jenna, and your willingness to share your uncertainties and perception that you lack experience compared to some members of the class (actually, I do too, so don't sweat it!) I'd like to have

seen you take more opportunities to interact with other peoples' ideas and images: your posts were very good, but kind of self-contained. I realise you have some constraints in terms of computer access, so that may be part of the problem, but if you can get opportunities to read and comment on your group members' messages it will enhance your own learning in the unit.

We also chose to make ourselves accountable to our students for our own online participation: the following message was appended to the first round of assessment e-mails:

As both part of your thinking about the unit, and some useful feedback for me, please feel free to score *me* on my posts in the Discussion Room, using the same categories (i.e. Excellent, Good, Par) on the four criteria in a return e-mail message.

This approach to online assessment seems to us to be flexible enough to allow us to embody our values in our practices, while at the same time being accountable and clearly specified enough to be fair to students in their goal of achieving at a high level in their courses.

(Provisional) Evidence of Success

In seeking to represent our phenomenological understanding of our students' learning experiences in the SMEC 612 unit, we realised that we are actively constructing a representation out of the fragments of textual evidence left lying around after the unit was completed—a little like trying to reconstruct a sculpture from the leftover stone chips! But the situation is not quite like that, because we are also the sculptors—we planned and designed the unit, taught, and evaluated it. Of course, the students were co-sculptors with us of the final shape of the shared teaching/learning experience that was the unit itself (the web site and assignments are only partial artifacts of the real learning). This metaphor is not sufficiently powerful for the task of describing the process of developing a rich representation of the design/action research process we have gone through over the past four years, and its effects on the learning of our students, but it does emphasise the constructed nature of this representation. That applies no less to the linear, inevitable-seeming tale of progress and growth presented than to the more tentative and complex discussion of student learning.

In talking about whether our use of web-based CMC enabled our students to learn better in the SMEC 612 unit, direct comparisons of grades or assignments across the three years are: (a) not really possible, because the unit itself and the assessment model changed so much and (b) not particularly useful, since the assessment is not by external objective tests but (as discussed previously) by holistic, intersubjective judgements of the quality of students' transformation of their own beliefs and practices.

Given this, what kinds of evidence can we present to support our claims that our students' learning was in some sense better because of the time and energy we expended in developing and teaching the online unit?

The first part of the answer is that the unit is better because it more fully embodies our professional and pedagogical values. Whitehead (1989) talked about experiencing ourselves as "living contradictions" in our teaching lives—holding certain values, yet having those values negated in our teaching practice. He suggested that this experience is the "engine" for improving education, as we strive to more fully embody our values in our practices. Conversely, if we continue to experience teaching as the negation of our values, stress and disillusionment can vitiate our effectiveness. The particular values on which we have concentrated most of our attention are those described above under the terms *open* and *critical discourse*, which address listening, empathy, openness to others' ideas, and the willingness to challenge our preconceptions. The evidence that we, as designers and tutors, have experienced a reduction of our living contradictions will have to be simply the assertion that this is the case, supported by the fact that we have been sufficiently energised and excited by the process to have continued to invest scarce resources of time and energy in the process. If CMC had in some way *increased* the conflict between our values and practices, we would have been more inclined to discard the experiment and revert to the paper-and-mail mode of teaching our distant students.

The second facet of the answer to the question of how the use of CMC has improved teaching and learning in this unit must come from a consideration of our students' learning, and the extent to which they have exhibited their developing skills in, and openness toward, open and critical discourse. The evidence for this is somewhat second-hand and interpretive, since it must be gathered from a variety of texts and conversations—e-mail messages, bulletin board posts, telephone interviews and face to face discussions. There is necessarily a selection process involved in choosing which tiny fraction of the over 1100 bulletin board posts in e-mail messages to use in this representation, and which voices to emphasize. We have made the attempt to use our pedagogical thoughtfulness to support the choices involved

in this hermeneutic phenomenological inquiry, but remain aware that other selections and other constructions are possible. Readers are free to explore the bulletin board postings for themselves at the URL given, and to construct their own rich understandings of the interactions and student learning in the unit.

In addition to the issues about assessing online participation, discussed above, three main themes arose in students' responses to the web-based unit. The first was students' approval of the perceived decrease in the isolation of distance study, the second (mainly involving one student) questioned the legitimacy of our imposition of the values relating to open and critical discourse on students, and the third related to the intellectual tools used in the unit.

From the beginning of our use of CMC in our distance teaching, students reported feeling much less isolated and alone, much more supported, and like members of a class group. They felt this was a very positive benefit of the CMC, even at the times when we were very frustrated by the small number of posts and relative under-utilisation of the Notice Board/Discussion Room pages. The quote by Laura in the "1997 – Drought" section was typical. Similarly, Evan wrote to his fellow students at the end of the 1999 unit:

I would like to say that I have enjoyed this experience immensely. It has been most rewarding, challenging and enlightening. Your experience and insights have added to an otherwise insular subject when studied on your own. I would love to do another. I wish you all the best and feel free to contact me anytime if I can help or provide any information.

Dara responded: "Evan, like you I really enjoyed the unit and contact with fellow students and David. This was my first semester and feel I like I have made friends during the course." One student in the 1998 unit, questioned whether our valuing of open and critical discourse on the part of students in the unit constituted some form of thought control, something akin to political correctness: she felt that we were saying "if you don't think and act the way we want you to, you cannot succeed in this class." Leaving aside the issue that succeeding in almost any tertiary course involves behaving in certain prescribed ways (i.e., studying, completing assignments, using correct referencing conventions, spelling and grammar, placing academic work within an appropriate research tradition), a considerable amount of energy was expended in clearly, calmly, and politely explaining the requirements of the unit to this student, both in Discussion Room posts and in private e-mail messages. In response to Margarita's third assignment, David wrote:

Your assignment does a good job of laying out these issues from your own perspective, but still falls short of the imaginative and empathic act needed to try to understand the issues from the perspective of another. Empathy is *not* seen by us as a “thought-style” to be imposed, but as a simple practical necessity for the very practical process of developing curricula with colleagues who *will* have different ideas, values and perspectives. (e-mail, 1998)

She responded:

Interestingly, “empathy” is not mentioned as a course requirement. In making these comments about my own work, you could be accused of lacking empathy and understanding on my perspective. After all, this assignment was specifically about my learning, no one else’s. For your information, I am quite successful in dealing with colleagues on a professional basis, and I question whether you can make a judgment about how empathic I am towards colleagues on the basis of a written assignment. (e-mail, 1998)

This issue continued to bubble away throughout the unit, exploding again in relation to the sixth assignment, and again in relation to the overall assessment in the unit. Margarita’s challenges were valuable in that they caused us to rethink the assessment strategies we used in the unit, and to make sure that our instructions and the information given to students were as clear and explicit as we could possibly make them. The challenges were also extremely stressful, however, with Margarita threatening to challenge her assessment with the Head of School and writing long messages attacking the integrity of the unit and the tutors. We were fortunate as tutors to have one another to rely on: when one was worn out, the other would “tag team” into the fray and continue!

Peter (both Peter and David were involved as tutors in 1998), using the metaphors of dancing or fencing to reflect on the forms of discourse exhibited during those events, wrote:

...when I attempted to engage Margarita... in an open and critical dialogue about her own standpoint, I found it impossible to dance with her, to engage dialogically with someone who seemed to be predisposed only to “thrust and parry.” Margarita, it seemed to me, had construed the concept of critical thinking in a way that directed criticism ever outward...Margarita [rejected] out-of-hand any suggestion that she was at fault, and ‘counter-punched’ with copious criticism of the pedagogy of the unit. (Taylor, et al., 1999b, pp. 431-432.)

Some students raised questions early in the 1999 unit about the relevance of the readings and unit approach to their teaching practices. Stan wrote:

I must admit that, as someone who enrolled in this course to improve myself as an educator, I am feeling some frustration at having to discuss the semantics of images of curriculum and at the same time wondering how this will improve my teaching. I can see some value in this process but it does seem to be a long path that we're being led down and I guess I'd like to see some drinking water at the end of it. Am I getting thirsty too soon?

Stan's reference to images of curriculum relates to our use of the mental tool of metaphor (Lakoff & Johnson, 1980) to problematic students' understandings of the notion of curriculum, and to offer a degree of critical distance to enable them to 'play' with the meaning of this central idea in the unit. Practising teachers tended to initially come to the unit looking for a much more prescriptive, concrete set of instructions for developing and implementing curricula, and our more philosophical introduction to the topic seemed irrelevant and waffly to some. Almost all of the students reconsidered this perception in the course of the unit, as the mental tools were later applied more directly to the contexts of their own practice, and came to value these mental tools as we did. Toward the end of the unit Annette wrote:

It is interesting to reflect upon my attitude to the reading I did at the beginning of this semester. I thought it all seemed too abstract and theoretical to be of any practical use to an experienced teacher, however looking back, I now see this was a way of setting the scene for the whole unit. It opened up my mind to the idea that the metaphors we use to help us understand curriculum colour the way we think and consequently influence our approach and attitude to curriculum development. This was a new and very powerful idea for me, one of several that I will take with me from this unit and attempt to apply to my work as a teacher.

Ensuring that students see their learning in the unit as relevant and professionally valuable remains an important goal for us, but encouraging them to raise their heads from their desks and take a broader view, and to suspend their disbelief in new ideas long enough to come to understand them, are also important goals. The practice of research and design is the iterative process of attempting to find the optimal solution for balancing these and a multitude of other goals and values in a dynamic, communication-based learning community.

CONCLUSION

This unit, and our use of web-based CMC in teaching more generally, remains very much a work in progress. The iterative processes of design, development, and critical reflection on our pedagogical practices continues to operate in new ways. We will teach the SMEC 612 unit again in the second half of 2000, and will use what we learn to improve the unit further, and possibly to begin offering other online units, and supporting our colleagues in their ventures into CMC.

We have also recently begun wrestling with the challenges of offering on-line courses to a group of students in a Taiwanese university. The challenges of delivering rich learning experiences for students for whom English is a second language, within what remains a highly text-oriented medium, are quite daunting. Online translation programs for languages using the Western character set are getting better, and may allow us to deliver courses in French, Spanish, or German in the future, but as yet it has been impossible to translate our sites into Mandarin or Cantonese. We are working with Taiwanese colleagues to improve this project.

By paying thoughtful attention, in Van Manen's (1991, 1990) sense, to our work, and by reflecting critically on our assumptions and practices, we believe that we can contribute to both the research literature of CMC and to the transformation of our own teaching—to embodying our values in our practice. This article is one way of inviting others to join us in the ongoing dialogical process.

References

- Belenky, M.F., Clinchy, B.M., Goldberger, N.R., & Tarule, J.M. (1986). *Women's ways of knowing*. New York: Basic Books.
- Burge, E.J. (1994). Learning in computer conferenced contexts: The learners' perspective. *Journal of Distance Education*, 9(1), 19-43.
- Dawson, V.M. & Taylor, P.C. (1998). Establishing open and critical discourses in the science classroom: Reflecting on initial difficulties. *Research in Science Education*, 28(3), 317-36.
- Dawson, V.M., Taylor, P.C., Geelan, D.R., Fox, R., Herrmann, A., & Parker, L. (1999). The development of epistemological pluralism through a web-based postgraduate curriculum course. In K. Martin, N. Stanley, & N. Davison (Eds.), *Teaching in the disciplines/learning in context: Proceedings of the 8th annual teaching learning forum*, University of Western Australia, February 1999. Perth, Western Australia [Online]. Available: <http://cleo.murdoch.edu.au/asu/pubs/tlf/tlf99/>

- Geelan, D.R. (in press). The empty centre: Power/knowledge, relationships and the myth of 'student centred teaching' in teacher education. *Australian Journal of Teacher Education*.
- Geelan, D.R. (1997). Epistemological anarchy and the many forms of constructivism. *Science & Education*, 6(1-2), 15-28.
- Geelan, D.R., Taylor, P.C., & Day, B. (1996). Teaching as a moral activity: Critical reflections in teacher education. *Research and Development in Higher Education*, 19, 258-262.
- Geelan, D.R., Taylor, P.C., Fox, R., Herrmann, A., Stapleton, A., & Dawson, V.M. (1999) Arcs, braids and webs: Exploring constructed narratives in a web-based distance education unit. In K. Martin, N. Stanley, & N. Davison (Eds.), *Teaching in the disciplines learning in context: Proceedings of the 8th annual teaching learning forum*, University of Western Australia, February 1999. Perth, Western Australia [Online]. Available: <http://cleo.murdoch.edu.au/asu/pubs/tlf/tlf99/>
- Gergen, K.J. (1995). Social construction and the educational process. In L.P. Steffe & J. Gale (Eds.), *Constructivism in education* (pp. 17-39). Hillsdale, NJ: Lawrence Erlbaum.
- Habermas, J. (1987). *The theory of communicative action*. London: Heinemann Educational; Cambridge, England: Polity Press.
- Herrmann, A., Fox, R., Taylor, P.C., Geelan, D.R., Dawson, V.M., Stapleton, A., & Parker, L. (1999). Co-constructing new understandings of online learning environments through critical reflection. In K. Martin, N. Stanley, & N. Davison (Eds.), *Teaching in the disciplines/learning in context: Proceedings of the 8th annual teaching learning forum*, University of Western Australia, February 1999. Perth, Western Australia [Online]. Available: <http://cleo.murdoch.edu.au/asu/pubs/tlf/tlf99/>
- Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: University of Chicago.
- Lemke, J.L. (1995). *Textual politics: Discourse and social dynamics*. London: Taylor & Francis.
- Noddings, N. (1984). *Caring: A feminine approach to ethics and moral education*. Berkeley, CA: University of California.
- Roth, M. (1997). *Computers and cognition: Toward a phenomenology of learning in the presence of computers*. Paper presented at the annual meeting of the American Educational Research Association, Chicago, March 1997.
- Solomon, J. (1987). Social influences on the construction of pupils' understanding of science. *Studies in Science Education*, 14, 63-82.
- Stapleton, A., Taylor, P.C., Dawson, V.M., Geelan, D.R., Fox, R., Herrmann, A., & Parker, L. (1999) Analysing hypertextual discussion for connected knowing: Units of analysis. In K. Martin, N. Stanley, & N. Davison (Eds.), *Teaching in the disciplines/learning in context: Proceedings of the 8th annual teaching learning forum*, University of Western Australia, February 1999. Perth, Western Australia [Online]. Available:<http://cleo.murdoch.edu.au/asu/pubs/tlf/tlf99/>

- Steier, F. (1995). From universing to conversing: An ecological constructionist approach to learning and multiple description. In L.P. Steffe & J. Gale (Eds.), *Constructivism in education*, 67-84. Hillsdale, NJ: Lawrence Erlbaum.
- Steffe, L., & Gale, J. (Eds.) (1995). *Constructivism in education*. Hillsdale, NJ: Lawrence Erlbaum.
- Swann, C. (1999). *Translating action research into design practice*. Paper presented at UIAH Conference, Tuusula, Finland, September, 1999.
- Taylor, P.C., Geelan, D.R., Dawson, V.M., & Stapleton, A. (1999a). Can teaching in a virtual classroom enhance real learning? *FID Review*, 1(2/3): 121-127.
- Taylor, P.C., Dawson, V.M., Geelan, D.R., Stapleton, A., Fox, R., Herrmann, A., & Parker, L. (1999b) Virtual teaching or virtually teaching? Does Internet-based teaching require multiple metaphors of mind? In K. Martin, N. Stanley, & N. Davison (Eds), *Teaching in the disciplines/learning in context. Proceedings of the 8th annual teaching learning forum*, The University of Western Australia, February 1999. Perth: UWA [Online]. Available: <http://cleo.murdoch.edu.au/asu/pubs/tlf/tlf99/>
- Taylor P.C., & Geelan D.R. (1997). Words for the boys: Gender and connected knowing in web-based distance education. *Proceedings of the Australasian Joint Regional Conference of Gender and Science and Technology (GASAT) and the International Organisation for Science and Technology Education (IOSTE)*, Curtin University of Technology.
- Taylor, P.C., Geelan, D.R., Fox, R., & Herrmann, A. (1997). Perspectives and possibilities: Electronic interactivity and social constructivist teaching in a science, mathematics and technology teacher education program. *Proceedings of the Australian Society for Computers in Learning in Tertiary Education (ASCILITE) Conference*, Curtin University of Technology, December 1997.
- Tobin, K. (1997). Alternative perspectives on authentic learning environments in elementary science. *International Journal of Educational Research*, 27(4), 303-310.
- Tobin K. (Ed.) (1993). *The practice of constructivism in science education*. Hillsdale, NJ: Lawrence Erlbaum.
- Tobin. K. (1990). Social constructivist perspectives on the reform of science education. *Australian Science Teachers Journal*, 36(4), 29-35.
- Van Manen, M. (1991). *The tact of teaching: The meaning of pedagogical thoughtfulness*. Albany, NY: State University of New York Press.
- Van Manen, M. (1990). *Researching lived experience: Human science for an action-sensitive pedagogy*. Albany, NY: State University of New York.
- Whitehead, A.J. (1989). Creating a living educational theory from questions of the kind, 'How do I improve my practice?' *Cambridge Journal of Education*, 19(1), 41-52.
- Zuber-Skerritt, O. (1992). *Professional development in higher education: A theoretical framework for action research*. London: Kogan Page.