Confrontivist learning theory has cognitive, social and cultural elements. A problem-solving approach is consistent with principles of instruction arising from constructivism, and is commonly observed in applications of computer mediated communication (CMC) in education. The nature of problems posed for solution, and the contexts for their solution, affect the nature and quality of learning. Many of the documented applications of CMC reflect the limitations and difficulties imposed by the constraints of formal school environments. Technology can be leveraged to help change schools and their communities into constructivist learning environments.

This paper uses a review of literature to assess the role computer mediated communication (CMC) might play in the creation and support of constructivist learning environments. The review covers theoretical perspectives on constructivist learning, the nature of learning environments, constructivist applications of CMC in primary and secondary schools, and the role of CMC in curriculum and school restructuring.

Theoretical perspectives on constructivism

Constructivism is often invoked in the context of discussions of the use of CMC in education. One of the primary propositions which characterises the constructivist view of learning involves the concept of cognitive dissonance, which refers to a cognitive conflict or incongruity requiring resolution (Savery and Duffy, 1995:31). The proposition is that such an incongruity provides the stimulus for learning and largely determines what the learner attends to, what prior experience the learner brings to bear in constructing an understanding, and what understanding is eventually constructed. The learner has a purpose for learning.

While the constructivist view is usually broadly understood to involve a process where the learner is actively creating his or her knowledge, perspectives on constructivism vary. The main emphasis of Piaget's work has been on mapping distinct stages of cognitive development. This emphasis has led some writers, such as Edgar (1995), to see constructivist theory as an individualistic and narrowly cognitive theory. However, the writings of Piaget also refer to the significance of collaborative work and of experience in the social/cultural environment (Hilgard & Bower, 1981; Ridgeway & Passey, 1991). Greater emphasis was placed on these factors in the work of Vygotsky (1986). Researchers have described a number of theoretical perspectives which reflect this broader view of constructivist learning. These include descriptions of sociocognitive learning (Needles & Knapp, 1994), situated learning (Brown, Collins & Duguid (1989), and social constructivist learning (Cobb et. al., 1992).

An issue central to the subject of this literature review, and about which there is some confusion and disagreement, concerns the notion of authentic tasks and experience. As has already been noted, central to the constructivist view of learning is the notion that learning happens when the beliefs, theories and perceptions of people are challenged. The learner's motivation to resolve that challenge provides the learning task with its authenticity. Constructivists with a cognitive leaning (e.g., Turner, 1995) would emphasise mental challenges as constituting constructivist learning tasks. Constructivists with a social leaning (e.g., Knapp & Glenn, 1996) would emphasise conversation and collaborative activities as constituting constructivist learning tasks. A constructivist with what I might call a cultural leaning (e.g., Perkins, 1996) would emphasise hands-on and real-life experiences as constituting constructivist learning tasks. Each type of learning task may be valuable. Each approach may involve providing opportunities for problem-solving, but the nature of the problem, and the context for its solution, make a very large difference to the nature and quality of the learning.
The nature of learning environments

The distinction drawn by Marshall (1992) between work-oriented and learning-oriented classrooms reflects the constructivist perspective. Teachers in work-oriented classrooms concern themselves with transmission of information, whereas those in learner-oriented classrooms facilitate the active construction of knowledge through an emphasis on problem-solving and understanding.

Savery and Duffy (1995:33) suggest that one of the vital principles in the social constructivist perspective is the ‘social’ part, that is, the characteristics of the learning environment, the context of learning.

Rather than simplifying the environment for the learner, we seek to support the learner working in the complex environment. This is consistent with both cognitive apprenticeship (Collins, Brown, & Newman, 1989) and cognitive flexibility theory (Spiro et al., 1992) and reflects the importance of context in determining the understanding we have of any particular concept or principle.

Several writers have attempted to describe what might constitute an effective constructivist learning environment and a variety of terms has been coined, including ‘community of learners’ (Brown & Campione, 1994), ‘knowledge building communities’ (Scardamalia & Bereiter, 1992), and ‘constructivist learning environments’ (e.g., Morrison & Collins, 1995; Wilson, 1995). Perkins (1996:vi) suggests that learning environments help us to ‘know our way around’, which includes:

...having a sense of orientation, recognizing problems and opportunities, perceiving how things work together, possessing a feel for the texture and structure of the domain. It encompasses not just explicit but tacit knowledge, not just focal awareness but peripheral awareness, not just a sense of what’s there but what’s interesting and valuable, as urged by Michael Polanyi (1958). Better than knowing that, knowing how, or like names for knowledge, knowing your way around resonates with the notion of a learning environment.

In seeking to create constructivist learning environments, Savery and Duffy (1995) suggest we attempt to preserve the richness and complexity that draws people into a context or activity in the first place, while providing tools and supports to ‘learn our way around’.

Similar to Perkins’ idea of ‘knowing our way around’ is the notion of epistemic fluency described by Morrison and Collins (1995). Epistemic fluency is the ability to participate in different culturally patterned ways of constructing knowledge, “...to recognise and practice a culture’s epistemic games, with their associated forms” (Morrison and Collins, 1995:43).

Epistemic forms are “target structures” that guide inquiry. Examples include lists, stage models, hierarchies, systems-dynamics models, and axiom systems. Epistemic games are sets of moves, constraints, and strategies, that guide the construction of knowledge around a particular epistemic form.

(Morrison and Collins, 1995:48)

Epistemic forms and games are language- and culture-based. The development of epistemic fluency takes place in the context of social interactions with other members of a culture who are more fluent than the learner, and where authentic, purposeful projects are the dominant activity (Morrison and Collins, 1995:43).

A number of writers conclude that teachers cannot fulfil the demands of providing an effective constructivist learning environment on their own (Goldberg & Richards, 1995; Jones et. al., 1994; Mandinach & Cline, 1994; Morrison & Goldberg, 1996; San Carlos Charter Learning Center, 1997; Xiaodong et. al., 1995). The challenge of finding ways to involve community members would seem to be inherent in our attempts to create constructivist learning environments. Technology and constructivist learning environments

Morrison and Collins (1995) suggest that technology can play some role in the development of epistemic fluency, but only if the technology supports and is supported by a constructivist learning environment. They describe a variety of software environments that can help students develop certain kinds of epistemic fluency. These include stand alone ‘communication’ environments that allow users to manipulate symbols and organise textual information; tools or construction kits, such as spreadsheets, that support students in carrying out tasks, and; interactive simulations and models, such as SimCity, which help students to create and observe scenarios (Morrison and Collins, 1995:43-4).

However, some writers observe that the use of technology as a constructivist learning activity in itself, represents a significant impoverishment of reality (Apple, 1987; Boudourides, 1995; Postman, 1992; Postman, 1995). Postman (1992:20) suggests that:

New technologies alter the structure of our interests: the things we think about. They alter the character of our symbols: the things we think with. And they alter the nature of community: the arena in which thoughts develop.

Morrison and Collins themselves, recognise the limitations of software environments in developing real epistemic fluency. They assert that schools will benefit most from “...communication tools that extend the community of practice to include participants from beyond the school walls” (Morrison and Collins, 1995:44), that is, from the appropriate use of CMC.

Many of the documented applications of CMC in education reflect the limitations and difficulties imposed by the constraints of traditional school environments. Typically, where CMC is used in conventional classrooms, in the study of conventional subjects, it is used as a source of information to assist with research, and as a link between locations, enabling personal communication such as computer pals activities, collaboration and sharing of information across cities, countries or continents (Harris, 1995; Poole, 1993). However, as Morrison and Collins (1995:43) point out, improved “...access to information probably contributes about as much to epistemic fluency as watching a tennis match does to learning how to play the game”.

Savery and Duffy (1995) argue that the problem-based learning model of
Barrows (1985, 1992) is consistent with the principles of instruction arising from constructivism. In fact, a problem solving approach is commonly observed in applications of CMC in education, and a number of writers point to the value of CMC in supporting project based learning. According to Joseph (1996) and Meagher (1995), the use of CMC in the learning of English supports the pursuit of projects relevant to the real world. They identify other benefits as improved motivation to research, collaborate and learn, more responsibility assumed for learning, and improved metacognitive skills due to having a real audience.

While many of the reported benefits of using CMC in traditional classrooms are significant, it has not been shown that such use leads to fundamental improvements in the nature and quality of learning. Such use does not reflect a substantial shift to education characterized by instructional principles that reflect a social constructivist perspective. The increased use of collaborative groups, for example, is a commonly observed concomitant of the use of CMC. But as Savery and Duffy (1995:32) point out, "...the real issue is what the goal is in using collaborative groups, since that determines the details of how they are used and how they are contextualized in the overall instructional framework."

This is a conclusion echoed by Topper (1995) who states that, "Simply applying technology toward collaborative learning without consideration for the complexities of social interaction and communication has not proven successful". The nature and context of the problem solving activities tend to reflect the ways teachers or researchers understand constructivism, and the assumed or actual physical, organisational and curricular constraints within which learning activities take place. Turner (1995), for example, acknowledges that formal school structures hinder the implementation of constructivist curricula, and describes attempts by staff at his school to develop 'computer constructivism' (not involving CMC) within the context of a 'constructivist classroom'.

Such attempts to apply constructivist principles reflect Riel's (1992) recognition that in most instances education will not change if innovative activities cannot take place in the classroom, at least initially. However, such an application of constructivism is largely cognitive in character, and suffers from the limitations of software environments identified above.

Within what sort of learning environment, then, can CMC support real, socially and culturally conceived constructivist learning? Xiaodong et al., (1995:59) identify five key principles that can be used as we attempt to design and develop efficient, constructivist learning environments. Such communities would provide students opportunities to:

1. plan, organize, monitor, and revise their own research and problem solving;
2. work collaboratively and take advantage of distributed expertise from the community to allow diversity, creativity, and flexibility in learning;
3. learn self-selected topics and identify their own issues that are related to the problem-based anchors and then identify relevant resources;
4. use various technologies to build their own knowledge rather than using the technologies as "knowledge tellers"; and
5. make students thinking visible so that they can revise their own thoughts, assumptions, and arguments.

While many of the characteristics of constructivist learning environments have no inherent dependence on CMC (e.g., Conrad & Hedin, 1991; Hedin, 1983; San Carlos Charter Learning Center, 1997; Williams, 1991), it can clearly play a significant role in supporting and applying several of these key principles. However, the application of such principles clearly necessitates substantial restructuring of curriculum and school organisation, and Goldberg and Richards (1995:6) suggest that "...technology can be leveraged to change schools and their communities into learning organizations".

**Curriculum and school restructuring**

Goldberg and Richards (1995) describe the Co-NECT school design and suggest that it provides a framework for school-wide restructuring that schools can use to change traditional roles and relationships into those of a true learning organisation. Morrison and Goldberg (1996) characterise the Co-NECT school design as one that focuses on technology integration, multi-grade clusters, team teaching and decision-making, performance-based assessment, and strong parent and community involvement.

At the center of the Co-NECT design is a vision of students, teachers, and other community members working together on a variety of significant projects of compelling interest and value to themselves, and to the larger community. (Morrison & Goldberg, 1996:216)

Jones et al., (1994) also recognise the necessity of significant school reform to enable the creation of effective, constructivist learning environments, and the role technology can play in facilitating that reform process. They identify curriculum reform as a key issue.

In order to have engaged learning, tasks need to be challenging, authentic, and multidisciplinary... Collaboration around authentic tasks often takes place with peers and mentors within school as well as with family members and others in the real world outside of school. These tasks often require integrated instruction that incorporates problem-based learning and curriculum by project. (Jones et al., 1994, paraphrased in North Central Regional Educational Laboratory, 1997)

Issues of curriculum development, integration and course sequencing are noted by several writers (Mandinach & Cline, 1994; Morrison & Goldberg, 1996; Roberts et al., 1990; San Carlos Charter Learning Center, 1997) as complex issues that need to be addressed in greater detail. Morrison & Goldberg, (1996:217) observe that "...the Co-NECT design acknowledges that projects are not the only suitable context for learning, and suggests that schools offer what the design refers to as 'seminars' and 'workshops'".

Assessment is also a significant issue addressed by a number of writers (e.g., Goldberg & Richards, 1995; Knapp &
Glenn, 1996; Mandinach & Cline, 1994; Morrison & Goldberg, 1996; Xiaodong et al., (1995). Performance-based assessment and portfolio assessment are widely agreed to be forms of student assessment compatible with the goals of constructivist learning communities. However, also widely perceived is the limiting factor of school accountability, and the notion that whole school change requires substantial school-level autonomy.

When teachers and administrators are held accountable only for results on traditional multiple-choice tests, there is a strong incentive to focus narrowly on the kinds of outcomes that such tests measure.

Morrison & Goldberg, 1996:219

Substantial recognition of the inconsistencies between conventional school environments and constructivist learning environments is further evidenced by California Senate Bill 1448, passed by the California House of Representatives in 1992, enabling the state to grant special charters to individual schools, waiving the requirements of the education code, in order to experiment with new methods of teaching (San Carlos Charter Learning Center, 1997).

Conclusion

Perhaps the issue which has come to stand out most clearly for me, as a result of conducting this literature review, concerns the need for the development, promotion and discussion of first principles of learning. Much poor practice and much of the resistance to school reform stems, I believe, from confusion about first principles. Many attempts at innovation become detached from their purpose, become superficial and meaningless, for want of clear guiding principles.

In this regard, perhaps a more fruitful question for consideration and fruitful question for consideration and promotion of first principles of learning is: ‘How can we use CMC in providing these?’

REFERENCES


