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Abstract: As part of an ongoing study into distributed learning environments, this paper examines the effects of concept mapping software when used as a collaborative learning tool. Preliminary findings are explored in relation to pre-service teachers' endeavour to distribute their learning collaboratively while working with the software in small groups.

Collaboration and concept mapping

Collaboration is seen as an important element of a distributed learning environments. Many designers of software design for the isolated and individual learner, and many programs reflect the belief that the interactions will be made by a single user. Group use of computers does not guarantee collaboration (Hooper, 1992). Katz and Lesgold (1993) point out that collaboration is more than cooperation: 'Cooperation ... involves a division of labour in achieving a task. Collaboration happens synchronously; cooperation is either synchronous or asynchronous' (p. 289). It is through discussion with others that students are able to negotiate the meaning of a concept by questioning existing understandings as well as explaining, evaluating and clarifying new and developing understandings. This process can be likened to a scaffold where the teacher and more capable peers support students as they work within their zone of proximal development (Vygotsky, 1978). Forman and Cazden suggest that true collaboration is not simply working together but also 'solving a problem or creating a product which could not have been completed independently' (cited in Repman, Weller, & Lan, 1993, p. 286). A number of researchers have explored how concept maps can be used as collaborative tools (e.g., Van Boxtel, Van Der Linden, & Kanselaar, 1997). Concept maps can be used in a variety of educational contexts and for many purposes such as: addressing students' misconceptions, assessing learning, determining prior knowledge, reducing anxiety in low ability students, and designing instructional materials (Jonassen, Reeves, Hong, Harvey, & Peters, 1997; Kennedy, & McNaught, 1997). In many of these settings, concept maps are used by individuals, or by a single student with a teacher, to delve more deeply into the student's understanding. However, when used as collaborative tools, they appear to promise far greater learning returns.

The study

Broadly, this study explored the implementation of computers as cognitive tools in an environment that acknowledged the distributed and shared nature of learning. In keeping with the view that learning is enhanced if it is distributed across a variety of sources found within the learning environment, students were encouraged to exploit their own intellectual resources (e.g., prior knowledge, metacognitive knowledge), physical resources (e.g., computers, journals) symbolic resources (e.g., diagrams, tables) and social resources (e.g., the teacher, peers). This paper focuses on the distribution of learning that occurred when the social resources were maximised in conjunction with the computer. In particular, it describes the preliminary findings that emerged when small groups of preservice teachers collaborated around the visual concept mapping tool *Inspiration* (Helfgott & Westhaver, 1997) in a graduate unit which examined cognitive theories of learning.

Students undertook weekly tutorials in groups of three, collaborating around the computer, with the computer and through the computer (Crook, 1996). For example, as part of the module exploring a categorisation of learning strategies, the groups were invited to critique their own lesson plans or videotaped lessons to identify the different types of learning strategies they typically encourage in their classes. Each group negotiated the existence of strategies in their lessons, which were subsequently built into an ongoing map for this topic. The evident imbalance in the maps enabled the students to realise that teachers often place greater emphasis on cognitive learning strategies to the detriment of metacognitive and resource management strategies. These

maps became the starting point for subsequent topics which encouraged students to make links between concepts and build a solid profile of an effective learner. While working on these sorts of tasks, four groups of students were audio-taped on three occasions. These students were also individually interviewed and kept self-reflective journals in which they recorded thoughts about their learning as it unfolded over the semester. This data was transcribed and imported into NUD.IST (Qualitative Solutions & Research, 1997) for analysis.

Preliminary observations

From day one, the computers served as motivational tools that engaged the students in activity and discourse. A preliminary examination of the data generated in this situation has seen the emergence of several themes:

Negotiation of meaning: This was clearly evident in the students' discourse where discussions often revolved around the formation of consensus in relation to the addition of a new concept or the linking of one concept to another. This negotiation process was unique to each group.

Metacognition: The visual representation of material encouraged the students to not only articulate their thoughts, but to reflect upon them in a metacognitive way. As a group, they often monitored their progress, evaluating and proceeding accordingly.

Cooperation vs: collaboration: There was no 'division of labour' in an attempt to work cooperatively rather than collaboratively, and concept maps were created synchronously rather than asynchronously. Students enjoyed collaborating and welcomed the opportunity to pool interpretations in an effort to understand concepts.

Group dynamics: The groups observed remained focused on the tasks and consistently engaged in the process. While group dynamics were certainly more productive in some groups than others, it was rare to find a non-contributor to the process. Students provided scaffolding for each other's developing understanding of concepts.

Visual learning: One of the strongest findings was the students' high regard for the visual representation of the subject matter. Throughout the tasks, in the interviews and journals, students noted that being able to picture the formation of their understandings provided them with a solid, meaningful record for later study and as a springboard for the development of subsequent topics. Most students said they would probably continue to create concepts maps in their future studies even if *Inspiration* was not available.

Limitations of software: As the maps grew in size, however, students were frustrated that they could only view one or two sections at a time. The outline view, which is a text version of the nodes, did not reflect the links between concepts as the students interpreted them. The outline view, therefore, was not an accurate summary of the interrelationships between concepts and could not be used as a point of reference for later study.

Conclusions and further study

In keeping with Vygotsky's (1978) contention that all mental functions have social origins and occur between individuals before they become internalised within the individual, this study capitalised on the potential offered by collaborative group learning. The mental functions that occurred within these groups were mediated by the use of *Inspiration* software, which is also aligned with Vygotsky's belief that individuals act through tools in their environment to gain greater control over their world. In this regard, the classroom resembled a learning community where the construction of knowledge was shared and distributed across a variety of resources. Further analysis of data will focus on the exploration of more data-driven themes and patterns, and will investigate other issues, such as the quality of the concept maps produced by the students, the influence of the electronic setting, and the students' discourse associated with actions such as revision and the creation of nodes and links.

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