COMPUTER BASED SIMULATIONS: COGNITIVE TOOLS FOR SECONDARY STUDENTS

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ABSTRACT

Under the research microscope, the effects of computer based simulation appear to be superior to conventional teaching in the affective domain. On the cognitive side, the impact appears to be less apparent and favourable results have often been qualified. A pilot study of the effect of a computer based simulation on cognitive performance, while inconclusive, suggested that issues associated with thinking processes, retention of understanding and transferability of understanding require additional study to establish a better understanding of the relationship between simulation and curriculum outcomes. A literature search has been conducted and research methodolgy is being refined to conduct a broader study.

INTRODUCTION

Throughout the 1980s Australiaís diverse education system found the necessary capital to invest in microcomputer systems. A significant goal for this expenditure was to achieve the O.E.C.D. target of one microcomputer per ten students by the commencement of the 1992 school year (Brumby, 1989). Roberts and Albion (1993), in a survey covering some ten percent of all Australian secondary schools found that forty three percent of the sample had achieved or bettered the target, while on average there were 14.35 students per computer. Based on these results, it is safe to say that microcomputers are now an established phenomenon in Australian schools.

In the world of politics, such figures would be touted as evidence of the successful integration of microcomputers into the learning environment. In the world of learning, this placement by itself, is not sufficient to guarantee that student learning will be enhanced. For this to happen, it is also necessary for students to engage in thinking.

This fact does not diminish the unique capabilities of microcomputers to present, receive, process and manage information useful for engaging students in thought. Rather, it serves to focus attention on the centrality of thinking within successful learning environments. In this respect, it is how machines, like microcomputers mediate a learnerís thought processes that becomes of interest.

THINKING: EXPLORING THE MINEFIELD

Exploring the potential of computers to mediate thinking necessitates an understanding of what constitutes thinking. Thinking though, is a nebulous and ill-defined term (Rooze & Northup, 1989). Accounting for it vagaries is like entering an uncharted minefield in which overlapping and often interchangeable terms stand ready to confound the uninitiated. This suggests that thinking is, itself, a global concept and that in order to clarify it, at least initially, one requires a global perspective.

Lipman (1991) provides such a perspective through two sharply contrasting paradigms of educational practice. The first, the standard paradigm of normal practice, is based on a traditional view of the world and education characterised by order. It is dominated by a belief in unambiguous, unequivocal and unmysterious knowledge, residing in non overlapping disciplines that can be authoritatively transmitted by teachers and absorbed by students. In such a world, thinking is said to have occurred if students have learned what is taught.

The second model, the reflective paradigm of critical practice presents a very disparate view of the world and education. The philosophical basis for this approach is not neatness but messy indeterminate situations (Barell, 1991), echoing the existence of a confused, amphibolic and mysterious world. Under such conditions, fallibility replaces authority and thinking becomes a tool for promoting understanding and good judgement.

In both cases, thinking is an intermediary action, albeit for different purposes. This difference in purpose represents the fulcrum of divergence between the paradigms and is characteristic of a product process dichotomy, what is most important, the finished products of thought, knowledge, or the means for attaining the product, inquiry. Lipman and others (Barell, 1991; Hyde & Bizar, 1989) contend that it is the latter.

Efforts to determine the morphology of thinking have led researchers to examine the thinking process at two levels, the macro or holistic level and the micro or component level. At the macro level research has centred upon contextualising the place of thinking within education. At the micro level, endeavour has identified the procedures or strategies that are employed as part of the process.

While both directions are important to an overall understanding of thinking, in attempting to incorporate the thinking process into the curriculum, some educators have incorrectly interpreted the existence of component level research as supporting the discrete teaching of thinking skills. Tinzmann, Jones & Pierce, (1992) consider such approaches to be implementing a basic skills approach. Hyde & Bizar (1989) describe the basic skills approach as reductionist, as a methodology that specifies components as skills or discrete behaviours to be mastered. Lipman (1991) describes thinking as a megaskill, as an orchestration of vast numbers of highly diversified skills and mental acts upon which more elegant and sophisticated operations are predicated. Both Hyde & Bizar and Lipman emphasise the need to maintain meaning acquisition and argue strongly that all approaches to teaching thinking should be contextualised to enlighten rather than trivialise. In contextualising thinking Lipman, Hyde & Bizar and others (Costa, 1992), rightly argue for the embedding of thinking within the total curriculum. In this way, the close relationship between what one knows and how one knows it is maintained. However, once again there is divergence, in that does one maintain the discipline base of the curriculum (Hyde & Bizar, 1989) or does the process of thinking become the substance of the curriculum with the disciplines providing content that possesses the ability to contribute to thinking (Costa, 1992). In reality, this is as much an issue of where does thinking fit as it is an instructional design issue.

DESIGNING LEARNING WITH THINKING IN MIND

The (re) emergence of thinking as a goal has co-incided with a resurgence of interest in games as curriculum tools (Magney, 1990). Games have value because they are embedded in culture (Conolly, 1988) and allow participants to learn about the world in which they live in a manageable way. However, games as curriculum tools, can only be justified when outcomes are greater or there are significant savings in curriculum time (Scriven, 1987).

One form of game that has become popular is the simulation. Simulations are working representations of reality that help to simplify complex situations (Conolly, 1988). When used within instructional contexts simulations can promote thinking. According to Breuer and Hajovy (1987) this is because simulations possess the ability to provide practice in

decision making - an outcome of thinking.

As a tool, computer-based simulation appears well suited to the integration of thinking in the curriculum and recent research has tended to highlight this point. Rivers and Vockell (1987) used simulation to stimulate thinking in science education. Results from general problem solving tests indicated that simulations can improve thinking skills. Woodward, Carnine and Gerstein (1988), in a study dealing with the diagnosis of health habits by students with learning difficulties, arrived at conclusions similar to Rivers and Vockell.

Although simulation possesses the potential to mediate thinking, it is not automatic. There is a long history of simulation being used to practice specific task related skills, without reference to cognition. Under such conditions, simulation has proven to be inadequate. Breuer and Hajovy contend that when simulations fail it is due to poor instructional design. Rather than properly integrating or embedding the simulation in the curriculum, educators have used them as isolated tools for self-directed instruction. Woodward Carnine and Gerstein reached a similar conclusion.

Integrating simulations within the curriculum is not a simple task. Stead (1990), in a study of first year university students interaction with a computer simulation, ëRunning the British Economyí, identified the need to closely link the information supplied by the tool with previously learned material. In this study, Stead repeatedly exposed the students to the simulation expecting to find improvements in their ability to understand and structure thinking over time. Instead, deficiencies persisted throughout the trials. In searching for reasons, Stead hypothesised that students differed in their prior learning and that the cause was an example of the differences between novice and expert behaviour. In a second study, Stead found the deficiencies persisted and concluded that simulations should only be incorporated in ways that integrate feedback with prior knowledge.

Another important instructional design issue relates to the delivery of instruction. Glenn and Rakow (1985) recognised the importance of managing computer simulation activities and considered that the most important aspect was the number of computers available. Penn (1988) in a study involving fifth grade students concluded that one computer may be as effective as many in the classroom. Bracey (1988), conducting a similar study with eighth grade students found that students benefit most from learning situations where they share the computer. Howard (1987) supports this finding, and suggests that co-operative learning using computer based simulations develops decision making and logical thinking.

DEVELOPING A STUDY

A pilot study (Morton, 1992) of two groups completing simulations (one computer based, the other pencil and paper) as part of a normal curriculum suggested that the lack of an identifiable difference was due to the inability of the design to discriminate important cognitive processes. In redesigning the study, the locus has been upon developing an understanding of these cognitive processes.

A key feature of this search has been the establishment of a specific type of thinking that relates well to both the discipline area, Geography, and the tool, computer-based simulation. The form of thinking most commonly cited is Critical Thinking (Beyer, 1987; Hyde & Bizar, 1989; Rooze & Northup, 1989). The major research question ìDo differences exist in studentsí critical thinking in Geography as a result of using computer-based simulations?î has been developed from this perspective. The application of this question should result in a better understanding of how students apply thinking and the role of simulations in developing and reshaping that thinking.

Prior to translating the question into a study it will be necessary to determine a specific catalogue of the components of critical thinking, identify how this list will fit holistically into a geographical framework and select an appropriate computer simulation. Beyer (1987) has identified ten intellectual operations and eleven procedures that will form the basis for projecting the components of critical thinking. Once the components have been refined they will be translated into a framework of intellectual processes that will provide a holistic framework. The framework, if it is to prove useful must enable the distinction between what Lipman (1990) has described as ìstrong senseî (or good) critical thinking, which involves discovering and rejecting prejudices and self deception and is therefore self-correcting, and ìweak senseî (or bad) critical thinking involving no more than a technical perfection of cognitive strategies, which is more likely to be self-serving.

The choice of simulation is somewhat more problematic, since to select one out of context, that is without properly considering its relationship to critical thinking and current syllabuses, would be to build into the study potential methodological flaws. A complete evaluation of the simulation is therefore central to the success of the study.

It is intended to employ a three group quasi experimental design in order to identify the impact of the two main variables, critical thinking and computer simulation. Data will be collected, using self reports, pre tests and post tests, conceptual maps, transcripts and value measures. By collecting both quantitative and qualitative data the richness of thinking and the role of computer based simulation in developing this richness will be identified.

CONCLUDING COMMENT

The decision of government to support the integration of microcomputers into the curriculum represents an opportunity to restructure education in ways that could lead to more appropriate outcomes. As Ragsdale (1982) points out, ìthe value of an education to a student is going to depend on the acquisition of skills which the computer has not acquiredî (p. 192).

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