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Developing and Measuring Students' Critical Thinking Skills When Using a Multimedia Information System

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DEVELOPING AND MEASURING STUDENTS' CRITICAL THINKING SKILLS WHEN USING A MULTIMEDIA INFORMATION SYSTEM

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DEVELOPING AND MEASURING STUDENTS' CRITICAL THINKING SKILLS WHEN USING A MULTIMEDIA INFORMATION SYSTEM

BY

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ABSTRACT

The purpose of this thesis was to examine the critical thinking skills six Year 7 students used and developed while working on an Multimedia Information System, Encarta.

The students' verbal interactions were recorded on audio tapes as they worked cooperatively in their groups. These interactions were transcribed and a content analysis technique was used to identify and calculate critical thinking indicator ratios. The content analysis was supported by field notes and students' word processed responses.

The results show that students in both groups collectively did engage in critical thinking, particularly with regards to the indicators, Importance, Linking Ideas and Critical Assessment. These critical thinking indicators also developed over the four sessions for students within each group, along with the indicator, Practical Utility.

Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature

Date .....17th..July..1997.....

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CHAPTER 1

Introduction

Background

This study is concerned with the role interactive multimedia (IMM), and particularly, multimedia information systems (MIS), play in developing critical thinking skills. Currently, curriculum debates around the world emphasise a need to encourage higher order thinking skills in education. Students need problem solving skills, associated with higher order thinking, to construct aspects of their knowledge (Vockell, & van Deusen,1989; Rowe, 1993). Furthermore, rather than teach higher order thinking skills in isolation, it is important that their development is incorporated into meaningful activities throughout the curricula (Alexander, & Frampton, 1994; Sherwood, 1989).

It is beyond the scope of this study to examine all forms of higher order thinking. Therefore, for the purpose of this study, critical thinking is targeted since it engages a core of cognitive skills necessary to the processes of higher order thinking (Splitter, 1991). Also, critical thinking should be, it is argued, fundamental to students' learning when using MIS. To date, it seems, criticism of students' use of MIS centres on the inability of students to engage information presented in MIS, using higher order cognitive processes (Oliver & Perzylo, 1994) . The principles and identifiers concerned with critical thinking, as used in this study, are given in Appendix A.

Significance

It is argued that the aim of educators today is to encourage students to engage in deep learning. Students should be able to: construct relevant content knowledge; operate at a higher abstract level; reflect on their own learning; enjoy the learning process; and be prepared to invest time in the pursuit of knowledge (Biggs & Moore, 1993; Newman, Webb & Cochrane, 1995).

Computers, or related media, including IMM, do not directly produce learning. It is rather the thinking processes that students engage in using IMM that generate learning. In this regard, multimedia needs to encourage students to use cognitive and metacognitive strategies, to facilitate students' learning (Rowe, 1993, Clark, 1994). In turn, this helps students to become self-reliant thinkers, and to develop important generic skills such as: problem solving; planning and management of study; self-monitoring; and evaluation (Woolfolk, 1990).

Currently CD-ROM interactive multimedia is growing in popularity as an instructional medium. Due to reductions in price and the educational focus of much of the software, multimedia is increasingly accessible to teachers. Therefore, it is timely to examine to what extent multimedia, and particularly MIS, can be used to engage students in developing higher-order thinking skills.

Purpose

The purpose of this study was to determine the critical thinking skills students used to engage in effective learning with MIS. In particular, to examine which critical thinking skills Year 7 students of high ability employ in activities where the computer is utilised as an information system, and where the students' task is to complete a complex investigation.

Research Questions

1. What critical thinking skills do students use when using a multimedia information system ?

2. Does experience influence the critical thinking skills demonstrated by students using a MIS ?

Definition of Terms

Higher order thinking skills (HOTS) refers to the ability to use cognitive processes to solve a complex problem. This ability, or skill, may require previous knowledge and experiences; a range of mental processes; strategies and understandings to solve problems, make decisions and learn new concepts; independent learning; and learning to learn (Dowling, 1990). Vockell and van Deusen (1989), identify four higher order thinking skills: metacognition; critical and creative thinking; core thinking skills; and thinking processes.

Metacognitive skills refers to students' awareness of their thinking while performing tasks and their improvement of their performance of those tasks (Vockell, & van Deusen,1989, Thorpe & Satterly, 1990, McLain, Gridley & McIntosh, 1991).

Critical thinking refers to students' reflective thinking which is about what they believe or do. It requires: judging credibilities and arguments; identifying conclusions; judging the quality of an argument; developing and defending an opinion; questioning, planning and judging designs; defining terms in context; open-mindedness; being well informed; and ability to draw appropriate conclusions (Vockell, & van Deusen,1989, Ennis, 1993, McPeck, 1981).

Interactive Multimedia refers to the simultaneous availability of a number of forms of media such as: text, sound; graphics; animation; video; and photographs in a computer package (Oliver, 1994a). Multimedia is often organised as hypermedia which is software made up of nodes and links. Nodes are units of information in any media form, while links allow the user to form relationships between units of information, thereby allowing students to construct a network of related information (Jonassen, 1995).

Multimedia Information Systems (MIS) refers to an electronic information system as a means of delivering information, using a number of media forms such as: text, sound; graphics; animation; video; and photographs (Oliver & Wild, 1995). MIS often employ the use of nodes and links to form relationships between units of information, thereby allowing students to traverse a network of related information.

CHAPTER 2

Literature Review

This literature review focuses on five significant areas: the role of H.O.T.S. in learning; the importance of critical thinking for students, particularly with regard to computer supported learning; the value and role of computers in a co-operative learning environment; the role of IMM, especially MIS in learning and particularly those features of MIS that may support the development of critical thinking; and the part style and personality can play in students' learning.

Higher Order Thinking Skills

Current debates highlight the importance of developing higher order thinking skills to facilitate deeper learning in students. Underlying this view is increasing evidence that students need to be able to adapt to a rapidly changing society and environment by solving problems rather than accumulating vast amounts of information.

There is now an ever increasing focus on problem solving, critical and creative thinking, and applying specific thinking skills to problem solving. Vockell and van Deusen (1989) categorise higher-order thinking skills into four overlapping types of skills and processes, namely: metacognitive skills; critical and creative thinking skills; core thinking skills; and thinking processes.

Metacognitive skills involve the use of strategies that enable learners to be aware of their thinking as they perform a task, and to use this awareness to improve their execution of the task. The absence of metacognitive skills in learners often leads to failure in learning since students are not equipped to monitor and evaluate their own learning and hence cannot modify unsuccessful or inefficient strategies readily (Vockell and van Deusen, 1989).

Ennis (1993, p180) defines critical thinking as ". . . reasonable reflective thinking focused on deciding what to believe or do." Students need to develop skills to be critical of their own thinking as well as critical of other's work in order to adapt and improve their thinking (Vockell and van Deusen (1989).

Creative thinking involves the appropriate application of original ideas that are flexible and useful in solving a new problem. It encourages students to adapt and modify their knowledge to new situations (Vockell and van Deusen (1989).

Core thinking skills can be taught directly to the students often as heuristics. They involve specific strategies that students are encouraged to use in their learning. For example, when confronted with new information, an effective core thinking strategy would be to make links to previous knowledge to facilitate better understanding (Vockell and van Deusen (1989).

Thinking processes involve several thinking skills, one or more of which are used to perform a task. These processes may be adapted to a range of situations. For example, problem solving, comprehension, and concept formation (Vockell and van Deusen (1989).

There is a great need for students to engage in learning experiences which develop higher order thinking skills, since they develop deeper learning in students, and at the same time, prepare students to be adaptable problem-solvers.

Measurement of Higher Order Thinking Skills

Although great emphasis is laid on the importance of students acquiring higher order thinking skills, such skills are evidently not easy to measure in students. For example, Thorpe and Satterly (1990) undertook a study employing four different measures of metacognition focusing on 144 primary students between the age of 7 and 11 years.

One measure used was "Generating Strategies", which is a subset of six items adapted from Kreutzer et al (1975) which required students to generate as many practical strategies as possible for memory tasks. The second measure was the "Word List Generation" taken from Tenney (1976), where students were given a cue word and asked to make a list of four other words.

Another measure was "Organisation of prose" created by Danner (1976), which involved students reorganising a number of sentences for a piece of prose to make it easy to read and remember. Finally, "Judging task difficulty" based on Flavell and Wellman (1977), which required students to judge between 10 word lists, indicating which is the easiest to learn and recall.

Using a factor analysis, they concluded that there is no common metacognitive component in students' learning, to enable reliable measures of metacognitive skill to be made. Not only does metacognitive ability appear to be task specific, but it also relies almost completely on students' ability to verbalise their metacognitive processes. In this context, there is a danger that deficiencies in students' language ability may belie assessment of their metacognitive skills.

Metacognition works better as a heuristic for determining the degree of awareness and monitoring of learning processes in students, and as such, is a general term to describe a range of higher order cognitive skills. Therefore, it would seem, it is not appropriate to measure metacognition (Thorpe, & Satterly, 1990).

Another study which examined the value of measurement of metacognition conducted by McLain, Gridley, & McIntosh (1991), reached a similar conclusion, in that the instrument used to determine metacognition proved to be invalid and unreliable. This study used a multiple choice instrument

called an Index of Reading Awareness (IRA) and a standardised test of reading, the Woodcock Reading Mastery Test-Revised (WRMT-R) which provided data for 133 students' (Year 3 to 5) in terms of their reading awareness.

The researchers' analyses questioned the internal and criterion-related validity of the IRA scale and concluded that the total score of the IRA be used as only one measure of students' reading awareness. Interestingly, the WRMT-R was found to be an inappropriate technique for measuring reading comprehension but did provide an indication of whether metacognition measured by the IRA is related to reading performance (McLain, Gridley, & McIntosh, 1991).

Therefore, although higher order thinking skills are vital to deeper learning, attempts to measure metacognition appear problematic in the extreme. Indeed, such problems could only be exacerbated for primary age students, since they are likely to find verbalising their thinking processes difficult.

Critical Thinking

It seems that to measure metacognition it is necessary to account for a range of higher order skills - and even then not be assured of a reliable or valid outcome. In this context, it has been decided to focus on critical thinking skills to obtain a reduced measure or indication of students' higher order

thinking. Undoubtedly, critical thinking has a direct impact on students' cognitive development (Vockell and van Deusen, 1989, Splitter, 1991).

Over the years there have been many perspectives and definitions given by philosophers and psychologists to explain critical thinking. Splitter (1991), surmised that for thinkers to become critical thinkers they need to be reflective, rule-governed, and judgemental about the world.

Haynes (1991), further argued that the nature of critical thinking is a function of its application in a particular situation. Students should be engaged in developing strategies for examining the reasonableness of what they say, by detecting hidden assumptions they hold, rather than blindly applying rules and formulae.

Critical thinking has also been defined as thinking about our thinking to explain and improve our individual thoughts. By understanding the way our minds work when solving a problem, working towards a goal, questioning, and analysing complex ideas we can learn to think more effectively. Critical thinking is a whole approach to making sense of our world rather than just one way of thinking (Chaffee, 1990).

Critical thinking consists of a range of activities such as thinking actively, questioning, thinking for ourselves, considering issues using different perspectives, and discussing issues in an organised way. Thinking actively involves the active engagement in the process of solving problems,

achieving goals and analysing issues. Asking relevant questions is a powerful thinking tool to explore various complex situations to obtain fact, interpretation, analysis, synthesis, evaluation and application of issues (Chaffee, 1990).

As young children we see only our own point of view which is based initially on the views of our parents and family, later progressing to others who have an influence on our lives such as friends and teachers. It is only when we begin to question these ideas that we truly begin to think for ourselves, making judgements based on good reasons or evidence (Chaffee, 1990).

However, a critical thinker must also be open to new ideas and different viewpoints which may be important to gain a complete understanding of a situation. This exchange of ideas allows us to discuss issues to clarify and construct a more balanced view. For the discussions to be fruitful, ideas need to be presented in a calm, logical manner supported by reasons and evidence (Chaffee, 1990).

However, Ennis (1993), identified critical thinking as ". . . reasonable reflective thinking focused on deciding what to believe or do." Critical thinking requires that people interdependently: judge credibilities; identify conclusions; judge arguments; develop and defend an opinion; ask appropriate questions, plan and judge designs; define terms in context; be open-minded; be well informed; and draw appropriate conclusions.

Critical thinking plays an important role in deep learning since it involves 'reflective scepticism' (McPeck, 1981, p7) of the problem area and knowing how and when to use it effectively. Critical thinking assesses thought processes as well as statements.

It is argued that students should engage in critical thinking from the beginning of their formal schooling and should develop critical thinking skills through practice within tasks that are curriculum based (Splitter, 1991, Haynes, 1991, Young, 1992). Woolfolk, (1990) states that through continual practice, students develop critical thinking skills which are useful and necessary in almost every situation people are faced with each day.

Siegel (cited in Splitter, 1991) identified three reasons why critical thinking is important for students. The first is that students should be respected as individual thinking people with the right to question, challenge and demand explanations. Secondly, critical thinking assists in preparing students for their future lives, encouraging them to be autonomous and make their own judgements. Finally, critical thinking prepares students to think in the various disciplines through the development of critical thinking naturally within the curriculum.

Splitter (1991) extends Siegel's perspective by identifying a relationship between critical thinking and constructing meaning. Critical thinking is necessary for students to make sense of their experiences and construct logical objective views about the world.

Critical thinking is vital to deeper learning within all contexts of students' lives. It develops reasonable, reflective thinking in students through the processes of making judgements, conclusions, opinions, questions, designing plans, and defining terms. In exercising critical thinking skills, students are more able to adapt and contribute to the rapidly changing society. Furthermore, it is proposed here that as critical thinking can be measured, we are able to provide some indication of students' higher order thinking skills.

Higher Order Thinking and Computer Supported Learning

There has been much research conducted concerning the role of computers in thinking and learning processes. Clark (1983, 1985, 1994) and Rowe (1994) have stated that no form of media, whether it be traditional such as a pen or in the form of a more recent technology such as a computer, produces learning. Rather, learning is a function of instructional strategies, embedded in or reflected by a medium, which assist students to develop thinking and learning processes.

Papert (1993), identifies two ways a computer can assist partly with thinking. Firstly, in given situations, defined by the software used, computers allow students to externalise implied expectations and to reflect on their thinking. Secondly, computers allow students to change and improve their ideas more easily. These claims have now appropriated some degree of orthodoxy, as a result of being explored, with a slightly different

focus, by a number of researchers, perhaps most recently by Jonassen (1995) and Reeves and Jonassen (in press).

Critical Thinking and Computers

Some educators believe that computers offer an exciting potential for accelerating and constructing the development of higher order thinking skills. Higher order thinking skills involve students using cognitive processes to solve a complex problem, drawing on previous knowledge and experiences. They require use of: mental processes; strategies and understanding to solve problems; decision making; learning new concepts; and learning to learn (Dowling, 1990, Sherwood, 1990).

Two distinct examples of how computers have been used to develop higher order thinking skills are Logo programming and graphic simulation. Logo programming has been used quite effectively to develop thinking skills in students using basic rule-oriented thinking skills to construct meaningful commands for the computer to execute (Black, Swan & Schwartz, 1988). Graphic simulations allow students to cognitively manipulate concepts that they would not normally have access to, such as simulated radio and television waves which are normally invisible to the eye.

There is a large number of studies that document the benefits, potential and actual, of grouping children to use computers in a cooperative learning experience, where students must use complex thinking processes such as negotiation, hypothesising, interpretation, prediction, and decision making (Sherwood, 1990). Braid (1995) describes these comprehensively.

For example, a study conducted by Anderson, Mayes, and Kibby, (1995) clearly indicated that the computer collaborative learning experience of a small group provided highly effective, and quality learning in individuals. In their studies, pairs of primary school students used hypertext to respond to tasks set by the teacher. Each student needed to keep track of their individual understanding of the concept to be able to engage in discussions with their peers. Students constantly and consciously reassessed their own understandings based on their previous knowledge, information provided by the hypertext, and contributions made by the other member of the group. This encouraged students to use critical thinking to develop their own understanding and contribute to the discussions which promoted deeper learning (Anderson, Mayes, & Kibby, 1995).

There are two specific reasons for this study to engage students in cooperative groups using computers. The first arises from the view that cooperative groups using computers are arguably the optimum learning environment, particularly in support of higher-order thinking skills such as

critical thinking skills (Vockell & van Deusen,1989). For example, in a study carried out by Newman, Webb & Cochrane (1995), a content analysis method was used to measure critical thinking of students engaged in face-to-face and computer supported group learning. They found that the computer supported co-operative learning allowed participants to develop important, justified and linked ideas.

A study conducted by Sherwood (1989) found that year 7 students work best in cooperative learning groups. Their on-task time was high throughout each session and discussions were continually focused on the problem assigned to the students. The students were also willing to listen and discuss different approaches to the problem with their peers.

The second is determined by the preferred methodology of the study, which includes accounting for students' authentic talk as a means of measuring their critical thinking processes. In order for students to be able to engage in critical thinking within computer supported, curriculum based tasks, they need a learning environment where they can naturally externalise, adapt and modify their ideas. Cooperative learning experiences encourage students to discuss and develop their critical thinking spontaneously, building, adapting and modifying individuals' ideas to formulate a critically developed group response.

Interactive multimedia is characterised by allowing students to interact with the computer by selecting, controlling and pacing their learning. IMM provides a full range of media such as text, graphics, sound, animation and video which allows information to be presented in a creative and motivating manner (Curtin, 1994, Small & Grabowski, 1992).

Interactive multimedia allows use of different media forms, stimulating a number of senses concurrently, gaining and maintaining students' attention. Since most interactive multimedia is in the form of hypermedia, students can access a range of relevant information by forming links between related nodes, from one screen to the next. This enables students to investigate a wide range of related data to build a network of appropriate information to address the question or task constructing individualised navigational paths (Jonassen, 1995, Small & Grabowski, 1992).

In a conclusion to a study conducted by Oliver and Perzylo (1994), a number of media elements were discussed in terms of their influence on students' learning. The strengths of IMM included the sounds and video clips from the program which sustained students' attention and encouraged them to use more descriptive language in their notes. However, students were reluctant to make use of photographs and took a significantly longer period of time to complete tasks due to note taking from the screen.

Furthermore, students collected a large amount of information using all media forms, little was evident in the final reports students submitted (Oliver, 1994). It would seem that the paper-and-pen format for presenting the final project did not encourage students to utilise the contents of The Mammals CD-ROM. Interestingly, a subsequent study conducted by Oliver (1994a) did improve the quality of students' final reports, by direct instruction in how to use, retrieve and report information using all forms of media.

The implications of this are that students must not only be made aware of the features of the MIS but also shown how to utilise all relevant information in their final responses and encouraged to use the note pad and word processor features.

Small and Grabowski, (1992) undertook an exploratory study using hypermedia to determine the information-seeking behaviour patterns displayed by the user and how motivation, prior knowledge, gender, and cognitive processing influences users' selection of information, and what is learned and retained. The results from this study indicated that three of the four motivational factors (interest, importance, and self-confidence) increased as a result of using the hypermedia system. Males' motivation increased overall while females remained constant (Small and Grabowski, 1992).

The information-seeking behaviours identified in this study, showed that students used one medium of information separately, rather than in integrated forms: video with sound, text or graphics. As with the Oliver (1994) study, this suggests that students need to be explicitly taught to use all sources of information in a MIS, to maximise opportunities for learning.

Interactive Multimedia, Multimedia Information Systems and Learning

A study using interactive multimedia was conducted by Oliver and Perzylo (1994). The purpose of the study was to examine the ability of young students to extract meaningful information from a hypermedia package in an investigation. A class of 27, Year 7 students with some previous experience of computer use in school participated in the study.
This study was conducted as part of a class project on mammals over a four week period. Students gathered information about mammals using the Mammals CD-ROM (National Geographic, 1990). The conclusion of this study showed that students were able to successfully gather relevant information, often in one 30 minute session (Oliver & Perzylo,1994).

The proposed study is designed to take this research a step further, to determine evidence of critical thinking within such investigation activities, identifying the critical thinking skills that are used in the activity and those that are developed over time through the activity using the features within Encarta. (See Appendix B for detailed list of Encarta features.)

Table 1

Encarta (MIS) Features

Features

Open ended - selecting, controlling and pacing learning
Simultaneous use of a range of media forms
Hypertext / hyperlinks
All forms of media found - text, pictures, sounds, maps, animation, video clips
Encarta Highlights
Note pad and word processor
Contents keyword search
Category Browser
Gallery Wizard/Find Wizard

Cognitive style and personality of Year 7 students

In order to identify the critical thinking skills students engage in, it is necessary to select upper primary students since their cognitive development is more capable of handling thinking at a higher level (Woolfolk, 1990). Another consideration with regard to cognition is students' personal characteristics. A study (Riding, Burton, Rees & Sharratt, 1995) conducted on 12 year old students clearly identified a relationship between students' cognitive style and external personality characteristics.

The cognitive styles analysis was used to measure students to determine whether their cognitive style was 'Verbal or Imagery' and 'Wholist or Analytic' (Riding, Burton, Rees & Sharratt, 1995). Those students who were rated as verbalisers were more active participants than imagers and tended to verbalise their thinking.

As a result, it was important for this study to identify and use students who are able to represent information by thinking verbally rather than those that predominantly used mental pictures for representing and processing information.

CHAPTER 3

Theoretical Framework

The preceding chapter clearly sets out the nature, direction and rationale for this present study. In particular, there is an acknowledgement here, that while higher order thinking skills are necessary to the development of deep learning (Biggs and Moore, 1993), this study is limited to the measurement only of critical thinking skills, as a reduced indicator of higher order thinking skills. The reasons for this limitation are set out in Thorpe and Satterly (1990) and Vockell and von Deusen (1989). Indeed, both Splitter (1991) and Ennis (1993) argue that critical thinking is an appropriate indicator of higher order thinking.

Thinking skills, in terms of both their development and their measurement, are better focused in small group cooperative activity (Anderson, Mayes, and Kibby, 1995). Thus, in order to extend the study undertaken by Oliver and Perzylo (1994), and to investigate more fully the impact the development of children's critical thinking, of an MIS, it is necessary to focus the present study on groupings of children working in a cooperative task structure.

The structure of this study is set out in Figure 1.

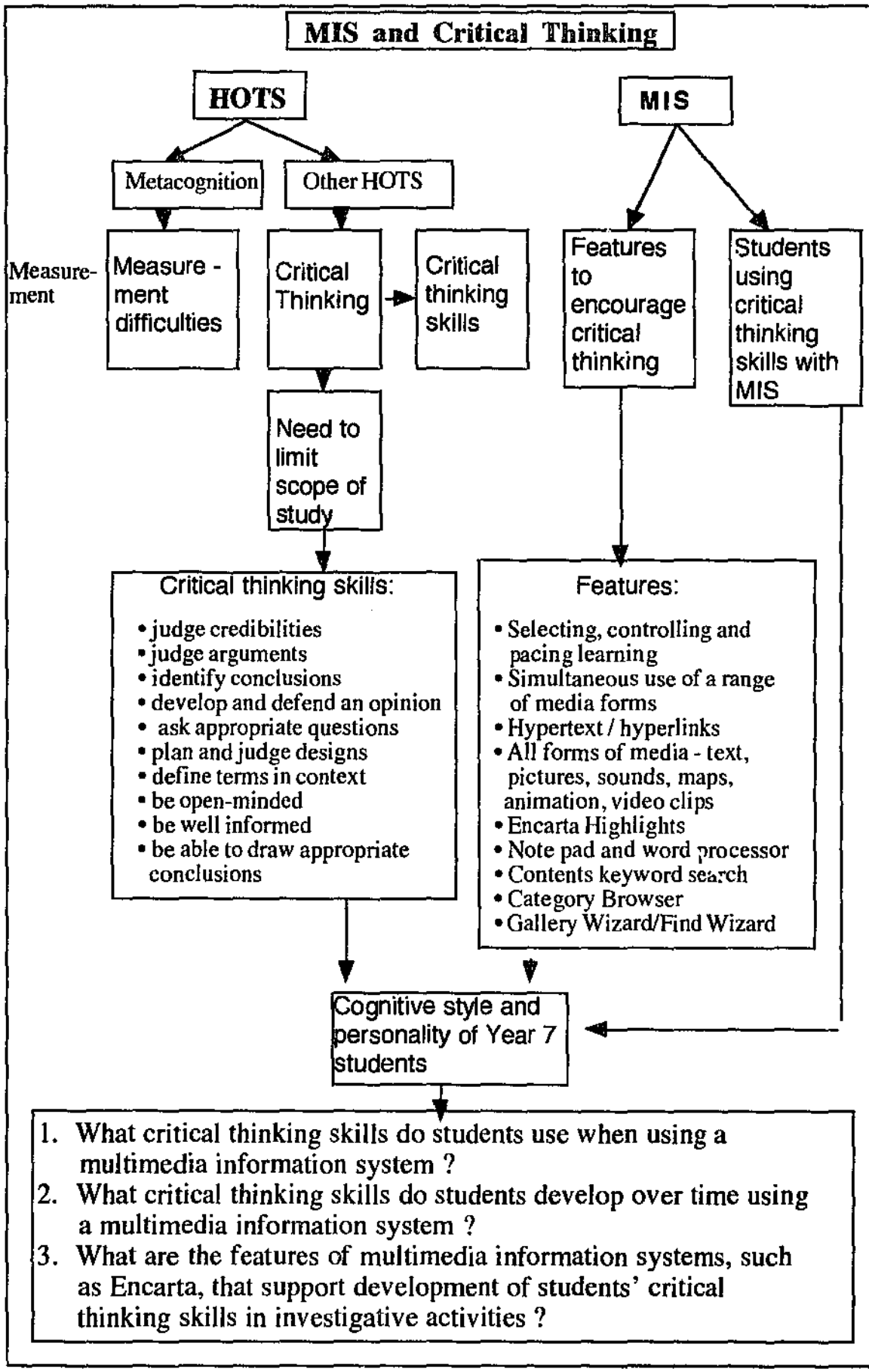

Figure 1. Theoretical Framework for the Measurement of Critical Thinking using a MIS

CHAPTER 4

Method

This chapter describes the method used in this study, which examined students' critical thinking skills when using the multimedia information system, Encarta. These skills were analysed using the students' transcribed, verbal interactions recorded on audio tapes, the researcher's observation notes and the students', word processed group responses to the set complex tasks.

Sample

This sample of students was selected from a co-educational, metropolitan primary school in Western Australia. Six year 7 students were chosen to form two groups. The 3 boys and 3 girls were high ability students. The students' ability levels were determined by the researcher in consultation with the class teacher based on formal and informal outcome measures for these students. The high ability levels enabled the students to understand and complete the set tasks, giving them the freedom to use the features of the IMM.

Each of the students participating in the study had only limited access to two computers in the classroom, with five of the six students having access to computers at home.

Design

This study is a descriptive case study of students' critical thinking skills as defined in Table 2. Students were introduced to the Encarta software package and subsequently responded to tasks using information from the electronic encyclopaedia. The data was collected using students' audio taped verbal interactions when completing the set tasks, field notes and students' word processed responses to the tasks. Encarta was chosen as a typical MIS, and are found in use in many schools.

The verbal interactions were then analysed using Newman, Webb and Cochrane's (1995) Content Analysis Technique. The field notes and word processed responses were categorised by features related to critical thinking. These features are described in Table 3.

Equipment

Encarta is a multimedia information system, comprising all forms of media typical of IMM software. It has six entry points in the form of icons namely: contents; category browser; gallery wizard; find wizard; Encarta highlights; and Enter Encarta. This allows students to access Encarta at different points and to locate desired data.

Encarta Highlights contains a stack of cards which give examples of what may be found in Encarta. This allows students to identify the different types and location of information. *Contents* is an A-Z listing of topics with a spell check and help facility. The category browser allows students to structure their information and to locate only information that is required. The *Gallery Wizard* and *Find Wizard* ask questions to help students search for information using: text, pictures, sounds, maps, animation and video clips. *Enter Encarta* gives access to the electronic pages of the encyclopaedia. It contains among other facilities, a note pad and word processor. The notes collected in the note pad can be used in the word processor to respond to the set tasks. All features and the critical thinking skills which relate to them are found in Table 3. A detailed list of Encarta features can be found in Appendix B.

Table 2

Critical Thinking skills as defined by Ennis (1993)

Critical Thinking Skills
a. judging credibilities and arguments
b. identifying conclusions
c. judging the quality of an argument
d. developing and defending an opinion
e. questioning
f. planning and judging designs
g. defining terms in context
h. open-mindedness
i. being well informed
j. drawing appropriate conclusions

Table3

MIS features related to Critical Thinking Skills

Encarta (MIS) Features	Critical Thinking Skills (see Table 2)
Open ended - selecting, controlling and pacing learning	a, d, f, h, i
Simultaneous use of a range of media forms	a, b, c, d, h
Hypertext / hyperlinks	d, f, g, h, i, j
All forms of media found - text, pictures, sounds, maps, animation,video clips	a, d, h, i
Encarta Highlights	f, h
Note pad and word processor	d, f, g, j
Contents keyword search	d, f, h
Category Browser	d, e, f, g, h, i
Gallery Wizard/Find Wizard	a, d, e, f, h, i

The Encarta was used by students to complete a number of complex tasks which were engineered to encourage critical thinking. In this context, Splitter (1991), argued that the teaching of critical thinking should be included in the curriculum, using strategies such as: asking investigative questions; developing assumptions; and searching for reasons and implications. Students should be given tasks that challenge their thinking, encouraging them to 'do' rather than to 'learn' a subject and to 'discover' things for themselves rather than 'memorise' facts.

This clearly supports the need for open-ended questions which encourage students to critically analyse and justify their responses to complete set tasks. The tasks for this study were constructed to encourage critical

thinking, by asking open-ended questions which are directly linked to the Year 7 social studies, health, language and science curricula and reflect students' interests (Appendix C).

The Encarta package was run on a Macintosh computer and the interactions students engaged in during each session were recorded on an audio tape supported by observation field notes produced by the researcher of the students' use of Encarta.

Procedure

This study was conducted over 5 sessions with each group having access to a computer for an hour and a half in the introductory session and then four, one hour sessions. The sessions were conducted as part of students' daily learning experiences but within an isolated room situated in another building within the school grounds, to ensure clear recording of interactions.

The first session served as an introduction to the study. During this session students and researcher become acquainted and a demonstration of the facilities of Encarta were presented to the students using highlights contained within the Encarta program and an example question illustrated by the researcher. Students became familiar with the equipment and program through the highlights facility and a sample question.

Students were encouraged to use the word processing facility within Encarta to summarise and elaborate on ideas as they researched. Particular focus was given to the use of all forms of media in their findings, to enhance critical thinking and the group discussion at the end of each session.

The following four sessions involved the students engaging in investigation activities, each based on a focus question presented by the researcher. For the last 5 minutes of the hour session the two groups and the researcher engaged in an open discussion of the findings, where students were encouraged to reflect, justify and consolidate their findings and experience of the activities and Encarta.

Pilot Study

Using this procedure, a pilot study was conducted in a one hour session with a group of three boys not included in the main study. During this session, students and researcher became acquainted and a demonstration of the facilities of Encarta was presented to the students using Encarta Highlights contained within the Encarta program and an example question illustrated by the researcher using the cards, features and facilities within Encarta. Students became familiar with the equipment and program through the a sample question directly related to the Year 7 science curriculum and students' interests.

Students were encouraged to use the note pad and word processing facilities within Encarta to summarise and elaborate on ideas as they researched using all forms of media in their findings, to enhance critical thinking and the group discussion at the end of each session. An initial discussion time of 15 minutes was found to be excessive, therefore the study discussion time was reduced to 5 minutes allowing students more time on Encarta.

The group were audio taped throughout the hour session. A content analysis method was then used to determine what critical thinking skills were used when using a MIS. The inter-rater reliability was determined at the pilot stage of the study between the researcher and another primary teacher. The results determined a reliability of 0.80 within 10 minutes of interaction which contained 83 distinct utterances.

The results of the content analysis for the pilot study determined that after an initial 5 minute introductory period there was consistent on-task group interaction throughout the session to constitute the analysis of the next 20 minute block of group interaction for each session since the discussions engaged in during this time directly related to gathering the information for the set tasks from Encarta.

Data Analysis Method

The content analysis method of critical thinking skills, as defined by Newman, Webb & Cochrane, (1995) was used to evaluate the quality of group learning rather than the performance of individual students. When determining critical thinking it was necessary to not only assess the statement a student might utter but also the wider meaning for the utterance constructed through the group interaction. These was achieved using indicators of critical thinking, (Appendix A) which in turn reflect critical thinking skills identified by Ennis (1993) in Table 2. A summary of the main Critical Thinking indicators is provided in Table 4.

The verbal, taped, and transcribed utterances collected for each of the group's interactions during each session were analysed using the Content Analysis Technique indicators (Appendix A). An initial 5 minute introductory period was allowed for students to settle, after which twenty minutes of each group's interactions were analysed for each of the four sessions.

Table 4

Summary of main critical thinking indicators

Abbreviations	Critical Thinking Indicators (Ennis, 1993)
R	Relevance
I	Importance
N	Novelty
O	Outside Knowledge
A	Ambiguities
L	Linking Ideas
J	Justification
C	Critical Assessment
P	Practical Utility
W	Width of Understanding

Using Newman, Webb, & Cochrane's (1995) analytical method, specific units of statements, such as phrases, sentences, paragraphs and messages, that contained one unit of meaning and denoted at least one of the indicators, were marked and counted, to avoid subjective judgements.

Presented below is an extract of students' group interaction when responding to the question concerning the need to protect the environment for animals as well as people. The analysis of this interaction, in terms of critical thinking indicators is provided below. The Critical Thinking Indicators are indicated in bold and are bracketed.

> Rachel> It is a product of the environment. . . . material of vegetation. Dependent on all of these are all living organisms. They use water, carbon dioxide and sunlight to convert raw materials into carbohydrates through photosynthesis. Animal

life is dependent on plants . . . [R+ I+ NI+ NP+ L+]

Rachel> Oh, hang on, look. This is change and temperature . . . influencing vegetation and animal life, ultimately forming the environment as it exists today. Oh, Environmental problems. [R+ I+ NI+ NP+ L+]

Mary> Ok, click on that.

Jane> No, but that's just like the problems. [C+]

Mary> Yeh, . . .

Jane> Control. . . used for . . . natural vegetation . . . [R+ JS+]

Rachel> Look ! Wild animals were slaughtered for food and destroyed as pests and predators. [NI-]

In analysis a plus (+) was given for critical thinking and a minus (-) for non-critical thinking. These results were then used to find the critical thinking ratio based on:

$$\text{ratio } x = (x^{+} - x^{-})/(x^{+} + x^{-})$$

converting the counts to $^{-}1$ (non-critical thinking) or $^{+}1$ (critical thinking). For example, for the boys' first session Critical Assessment score there were 24 critical thinking statements and 2 non-critical thinking statements, therefore:

$$\text{Critical Assessment Ratio} = (24 - 2) / (24 + 2)$$
$$= 22 / 26$$
$$= 0.85$$

Once the content analysis had been conducted on all 8, twenty minute transcriptions, collected for each of the 2 groups over the 4 sessions, graphs were constructed to show the overall mean for each indicator of the content analysis technique obtained for the group of students, with particular reference made to those indicators which showed the highest score determining which skills were used most. Also, inter and intra group comparisons were made of the critical thinking indicators students displayed in the four sessions collectively.

Descriptive field notes of students' observed critical thinking and interaction with the Encarta were also used to support the verbal analysis described above. These field notes were organised to reflect three features identified in Encarta, that relate to critical thinking development. A note was made of the counter on the audio tape machine to ensure notes coincided with the verbal interactions.

The use of transcribed audio recordings of interactions, descriptive field notes and word processed responses to the tasks reflect the use of triangulation to address internal validity. By using three different viewpoints in the analysis the researcher can not only be more confident with her findings but ensure that the final evaluation reflects the 'multiple realities' (Burns, 1994, p 273) of the specific social context. Ennis (1993) also states that naturalistic observation such as a case study is particularly valid as a methodology in the investigation of children's critical thinking.

Limitations

This is a descriptive study of the critical thinking skills students engaged in when using a MIS, Encarta, to complete curriculum specific tasks. The transfer of critical thinking cannot be assumed for all content areas. Students engaged in constructive critical thinking using Encarta but may not necessarily be able to transfer the critical thinking to other curriculum contents, nor to the use of other types of examples of MIS.

Therefore, it must be noted that the findings from this study are specific to this situation only. However, by replicating the methodology it should be possible to investigate critical thinking in other contexts.

Problems associated with the content analysis method revolve around the fact that some of the indicators which rely on subject specific knowledge. Newman, Webb, & Cochrane, (1995) recommend that the transcribed interactions should be marked by someone with the subject knowledge covered by the tasks.

Ethical Considerations

Consent was obtained from the principal, class teacher and the six parents whose children participated in the study. (See Appendix D.) Student confidentiality in regard to audio tapes, field notes and responses to questions will be maintained by securing data in a locked draw. During transcription, names were changed, the audio tapes destroyed and the transcriptions kept on a personal computer protected by a security password.

CHAPTER 5

Data analysis

This chapter describes the means of analysis used on the verbal transcriptions, field notes and students' final word processed responses to the tasks using the MIS package Encarta. The verbal interactions were analysed using the content analysis technique and were supported by the field notes and the word processed responses.

Content Analysis Technique used on Transcribed Verbal Interactions

Newman, Webb, & Cochrane's (1995) Content Analysis Technique was used to analyse the critical thinking indicators students used while working on the Encarta to respond to the complex tasks. Eight blocks of transcribed, verbal interactions were analysed each consisting of 20 minutes of interaction for each group. These were chosen from the beginning of each of the four sessions immediately following a 5 minute introductory period.

Based on the recommendations of Newman, Webb & Cochrane (1995), only those statements such as: phrases; sentences; paragraphs or messages that contained one unit of meaning and denoted at least one of the indicators were marked and counted. This generally involved omitting statements that referred directly to operational commands of Encarta.

For example, the following interaction is categorised as comprising only operational statements:

Rachel> So, what do I do ? Highlight it ?

Mary> Yeh.

Rachel> Ok.

Jane> Just go down.

Mary> Ok. Now cut. Put where you wan' it.

Each 20 minute block of group interactions was analysed using the Content Analysis Technique Indicators found in Appendix A. These critical thinking indicators are summarised in Table 4, and described below. Within each of these indicators positive and negative critical thinking sub-indicators were used to define the various statements made by the students during their group interactions.

Relevance Relevance was defined in terms of being either relevant to the task or irrelevant to the task. Students' statements were analysed according to whether or not the statements related to the questions. For example, a relevant statement when dealing with the question concerning the comparison of our civilisation with that of the Mayan's :

David> It should be here. The Mayan religion centred about the worship of the large number of Mayan gods . . .

An irrelevant statement which produced a diversion from the task:

David> I was wondering what was wrong, it was wobbling on the chair.

Importance Importance was defined as either important or unimportant points or issues related to the tasks.

For example, an important point is provided in Rachel's statement:

Rachel> They produced pottery unequalled in the new world outside. Ok. coloured beads and copper bells were used as units of exchange. Copper was also used for ornamental purposes as was gold, silver, jade, shells and colourful plumage.

An unimportant and misleading statement :

Rachel> Look ! Wild animals were slaughtered for food and destroyed as pests and predators.

Novelty Novelty was defined as using new information, ideas or solutions to respond to the tasks. The positive critical thinking indicators were given for statements where new problem-related information, new ideas for discussion, new solutions, welcoming new ideas, and learner originated ideas were used. For example :

David> . . . cacao beans as units of exchange. So that was their money, hey ? Sort of.

John> Go back and up.

David> . . . cacao beans and copper bells . . .

Rick> Cacao.

David> Ca-co-a. No it's a-o.

Rick> Try spelling it with an a.

John> . . . cacao beans and copper bells . . .

Negative uncritical thinking (Novelty) indicators were given for statements where information was repeated, false or trivial leads used, first solutions accepted or new ideas quashed. For example :

John> Write down . . . The Mayan civilisation ceased to exist for reasons unknown.

David> Ok ? The what ?

John> The Mayan civilisation . . .

David> Yeh, but we know the Mayan civilisation . . . Ok ? Which one ? The Mayan ?

John> The Mayan. No. The May-ans.

Rick> The May-ans.

Outside Knowledge Outside knowledge was defined as using information that originated from the learner. The positive critical thinking indicators involved use of personal experience, reference to course material, use of

relevant outside material, use of previous knowledge, use of course related problems, and welcoming outside knowledge. For example :

David> . . . machinery. . . there you go. Turntables that keep on moving, you have to spin it.
Rick> Shape it with your hands like this.

The negative uncritical thinking indicators included squashing outside knowledge and holding to assumptions and prejudices. No negative statements were found for Outside Knowledge.

Ambiguity Ambiguity referred to the clarification or confusion of statements. The positive critical thinking statements included clear, unambiguous statements, and clarification of ambiguities through discussion. For example :

Rachel> What do you mean ?
Jane> . . . had several different ways . . .
Rachel> of communicating. Some of these were . . . no, they developed methods of notation and recorded astronomy.
Jane> They had several . . .
Rachel> . . . ways of communicating. we've got to say what sort of ways they had.
Jane> They . . . instead . . . We write on paper and they write on . . . carve and paint.

Rachel> Ok, so . . . what shall I write ?

Mary> You have to write the ways they do and then you write what we do.

The negative, uncritical thinking statements consisted of confused statements and continually ignoring ambiguities. For example :

Rachel> I'm going to write . . . because . . . as well as ourselves because . . .

Jane> . . . otherwise we will all . . .

Mary> No, because there won't be anymore kind of that species or . . .

Jane> . . . otherwise there won't be any of that species

Mary> Does that make sense ? Ok, ignore me.

Linking Ideas Linking ideas referred to association and interpretation of ideas. The positive, critical thinking indicators focused on the associations made between facts, ideas and notions, and creating information from data collected. For example :

Rachel> As populations increased and technology improved and . . . the human impact on the environment was . . .

Jane> . . . expanded however . . . problems arose.

Rachel> In fact the environmental problems have effected humans or something. So we could put that in the notes couldn't we ?

The negative, uncritical thinking indicators consisted of repeating information without adding any new information and sharing an opinion without adding any personal comments.

Rachel> . . . such as the snow leopard is extinct . . .

Jane> . . . are threatened with extinction. The snow leopard is extinct.

Justification Justification involved rationalisation of ideas. The positive, critical thinking indicators involved providing proof or examples, justifying solutions, and determining advantages and disadvantages of a solution. For example :

Rachel> Well, they built the houses different. But we don't need all that, we just need . . .The pyramids . . . get rid of that. The pyramids were built in successive steps with basic cut stone blocks and generally had a steep stairway built into one or more of their sites.

The negative, uncritical thinking indicators referred to irrelevant questions or examples, giving solutions without explanation or giving several solutions without suggesting which is the most appropriate. For example :

Mary> So what shall we put ? The Mayan culture . . .

Rachel> Hang on.

Jane> Architecture. Shall we put all that in ?

Rachel> Don't put architecture.

Critical Assessment Critical assessment referred to the evaluation of ideas and information. The positive, critical thinking indicators involved the evaluation of contributions made during group interaction, and the teacher prompting for critical evaluation. For example :

David> We've talked about the architecture. We have to talk about the pyramids now, remember ?
John> What pyramids ?
David> Remember ? Why they built it. Religious factors.
Rick> I think we wrote about that.
David> No we haven't done it yet. We've just done the architecture.

The negative, uncritical thinking indicators involved uncritical acceptance or rejection of an idea by group members. For example :

Rick> What's an animal on the verge of extinction ? Rhinoceros ?
John> Na.

Practical Utility Practical utility involved the use and discussion of practical solutions. For example :

David> The Mayans, capital M, built step pyramids . . . pyramids for religious purposes.
John> Yes, we need to do the areas, 'ey ?

David> Oh we already wrote that 'ey ? Can you undo it ? Oh, don't worry about it.

John> What shall we write about now ? Do you want to write about the Mayan religion ?

Rick> Keep writing.

John> We need to change some words in there.

The negative, uncritical thinking indicators were treatment in a vacuum and use of impractical solutions. No statements were found in this study.

Width of Understanding Width of understanding referred to either a narrow discussion or a widened discussion. No examples were found in this study. So all discussions were focused on the information required to address the set task.

The analysed data comprising 8, 20 minute group verbal interactions has been presented in the form of ratio tables and graphs presented in Chapter 6.

Field Notes

Field notes, consisting of observations made during each sessions, were used to support the verbal interaction transcriptions through observation. Notes were made according to observations of students' selection, control and

pacing of their learning, simultaneous use of a range of media forms, hypertext / hyperlinks, all forms of media found - text, pictures, sounds, maps, animation,video clips, Encarta Highlights, note pad and word processor, Contents keyword search, Category Browser, and Gallery Wizard/Find Wizard. (See Table 2.)

Students' Word Processed Task Responses

The students' word processed responses to the tasks were also used to support the transcribed verbal interactions. Analysis was made of the depth of the responses students made focusing on the critical thinking skills defined by Ennis (1993) and the students' use of a range of media forms (text, pictures, sounds, maps, animation,video clips), and hypertext / hyperlinks. Examples of word processed tasks can be found in Appendix E.

The results of the analysed data for the content analysis technique, field notes and word processed responses are presented in Chapter 6.

CHAPTER 6

Results

This chapter presents the results produced by the data analysis discussed in chapter 5. These results are based on the two groups', verbal interactions, the field notes collected by the researcher and the word processed responses of students' responses to the complex tasks set while using the Encarta electronic encyclopaedia.

The six students who participated in the study were grouped into two groups each containing 3 students. The verbal interactions each group produced in the four sessions were analysed into positive or negative critical thinking indicators using the scoring criteria described in Table 4 and Appendix A.

Critical Thinking Indicators used and developed with Encarta

To determine what critical thinking skills were used by the six students over the four sessions, the critical thinking indicator ratios were used for each group for each session to find the mean ratio and standard deviation for each indicator.

Table 4 shows the critical thinking ratios used for each of the indicators defined in Appendix A by (Newman, Webb & Cochrane, 1995).

Table 5 shows the collective means of critical thinking indicators obtained for all students in the 4 sessions. These results are presented in a graph in Figure 2. Two major findings are evident from this data. The first clearly indicates that the highest critical thinking indicator ratios were obtained for Importance, Critical Assessment and Linking Ideas. Each of these critical thinking indicators scored a mean ratio of between 0.90 and 0.95, suggesting a consistently high level of critical thinking for these indicators. The second major finding shows that Novelty and Justification scored a negative ratio, indicating non-critical thinking for these two indicators.

Table 5

Critical thinking indicator means obtained in four, 1 hour sessions using Encarta

Critical Thinking Indicators	Boys 1 (n=3) Ratio	Girls 1 (n=3) Ratio	Boys 2 (n=3) Ratio	Girls 2 (n=3) Ratio	Boys 3 (n=3) Ratio	Girls 3 (n=3) Ratio	Boys 4 (n=3) Ratio	Girls 4 (n=3) Ratio	Mean	(SD)
R	0.52	0.53	0.20	-0.25	0.80	0.02	-0.02	0.33	0.26	(0.35)
I	0.78	1.00	1.00	0.67	1.00	1.00	1.00	1.00	0.93	(0.13)
N	0.11	-0.39	-0.40	-0.56	-0.16	0.08	-0.67	-0.78	-0.35	(0.33)
A	1.00	0.80	1.00	1.00	1.00	0.25	0.33	0.60	0.75	(0.32)
O	1.00	1.00	1.00	0.00	1.00	0.00	1.00	1.00	0.75	(0.46)
L	0.38	0.78	1.00	1.00	1.00	1.00	1.00	1.00	0.90	(0.22)
J	-0.25	-0.08	-0.25	0.71	-0.08	-0.08	-0.29	0.00	-0.04	(0.32)
C	0.85	0.76	1.00	1.00	1.00	1.00	1.00	1.00	0.95	(0.09)
P	-1.00	0.60	1.00	1.00	1.00	1.00	1.00	1.00	0.70	(0.70)
W	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(0.00)

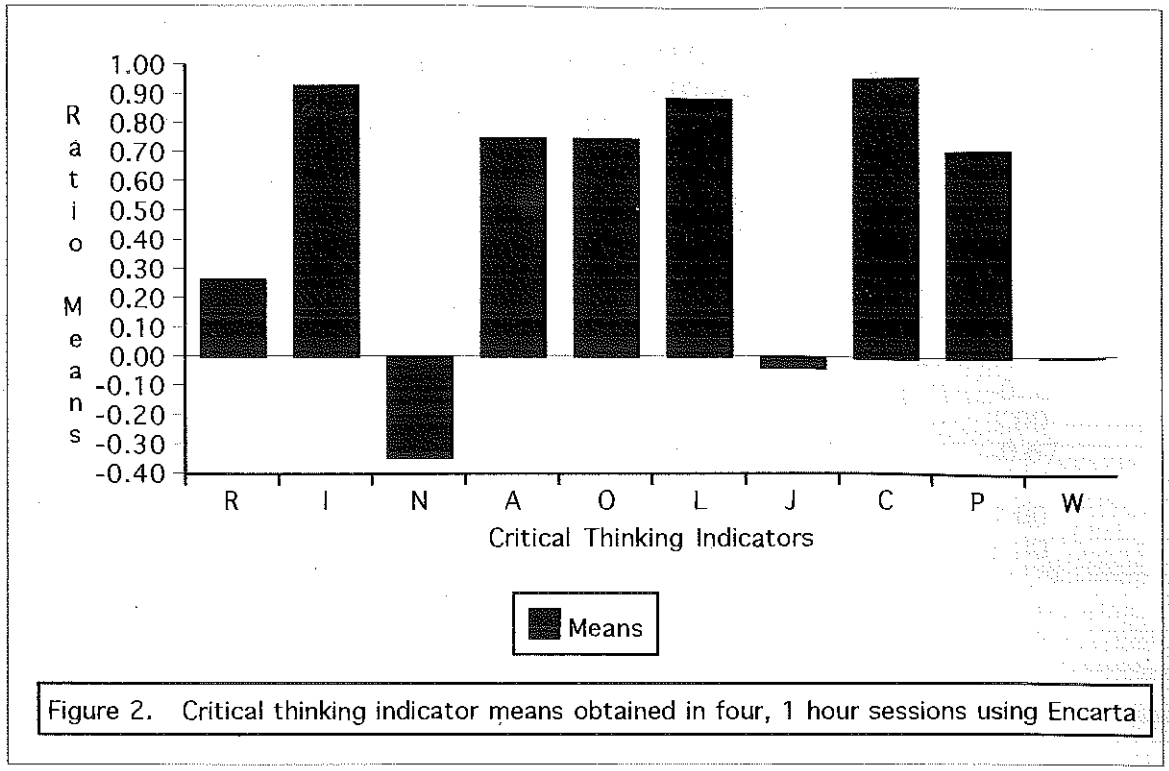

Figure 2. Critical thinking indicator means obtained in four, 1 hour sessions using Encarta

Table 6 and Figure 3 show the ratio for the boys' critical thinking indicators identified in the four sessions. The major finding of these results is that for the Relevance, Importance, Ambiguity, Outside Knowledge, Linking Ideas, Critical Assessment and Practical Utility indicators the boys' ratios were positive showing that the boys were engaged in these critical thinking skills over the four sessions. Whilst for Novelty and Justification there were negative mean scores indicating areas of non-critical thinking. Width of Knowledge did not score in any of the four sessions.

Table 6.

Boys' critical thinking indicator ratios identified in the four sessions using Encarta

Scoring Criteria	Session One (n=3) Ratio	Session Two (n=3) Ratio	Session Three (n=3) Ratio	Session Four (n=3) Ratio
Relevance	0.52	0.20	0.80	-0.02
Importance	0.78	1.00	1.00	1.00
Novelty	0.11	-0.40	-0.16	-0.67
Ambiguity	1.00	1.00	1.00	0.33
Outside Knowledge	1.00	1.00	1.00	1.00
Link Ideas	0.38	1.00	1.00	1.00
Justification	-0.25	-0.25	-0.08	-0.29
Critical Assessment	0.85	1.00	1.00	1.00
Practical Utility	0.00	1.00	1.00	1.00
Width of Understanding	0.00	0.00	0.00	0.00

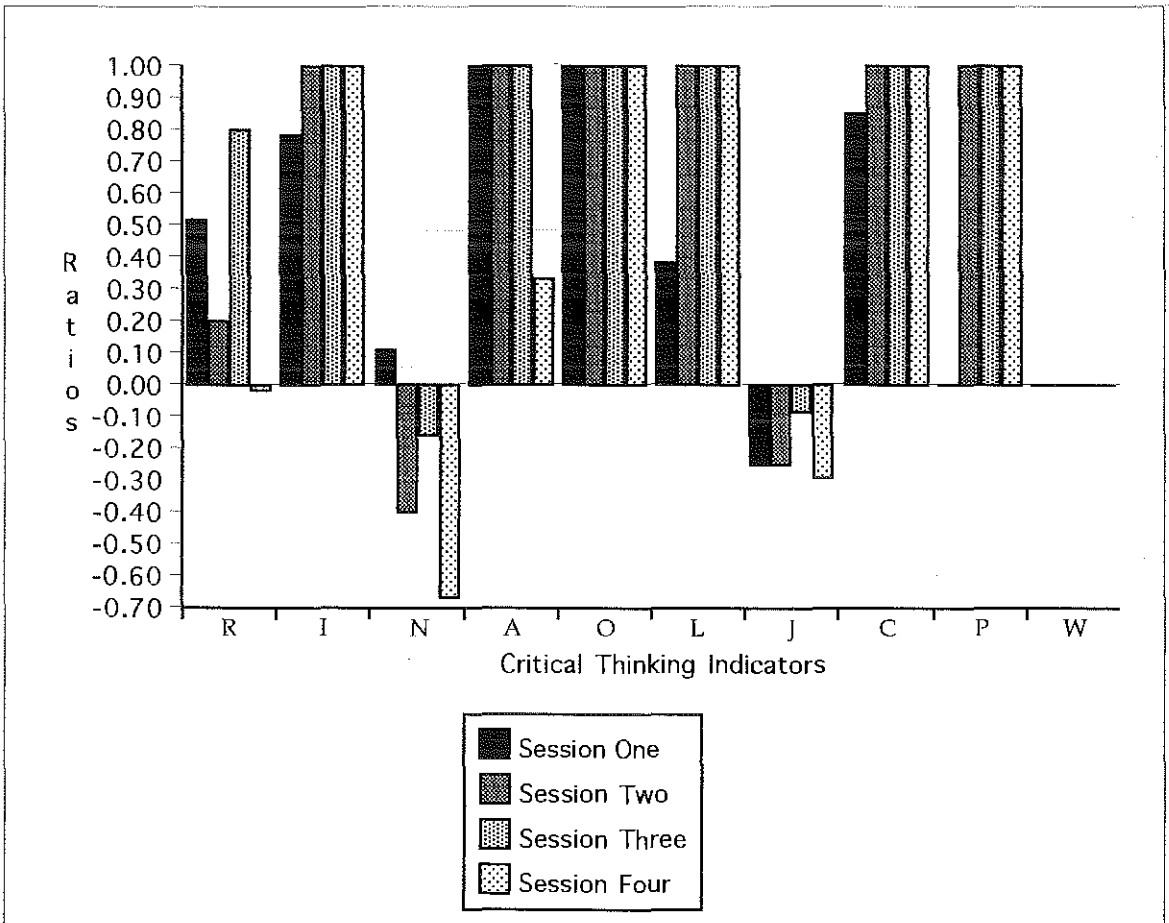

Figure 3. Boys' critical thinking indicators identified in four, 1 hour sessions using Encarta

Table 7 and Figure 4 show the ratio for the girls' critical thinking indicators identified in the four sessions. The major finding of these results is that for the Importance, Ambiguity, Outside Knowledge, Linking Ideas, Critical Assessment and Practical Utility indicators the girls' ratios were positive showing that the girls were engaged in these critical thinking skills over the four sessions. Whilst for Relevance, Novelty and Justification there were negative mean scores indicating the areas of non-critical thinking. Once again Width of Knowledge did not score in the four sessions.

Table 7.

Girls' critical thinking indicators ratios identified in the four, 1 hour sessions using Encarta

Scoring Criteria	Session One (n=3) Ratio	Session Two (n=3) Ratio	Session Three (n=3) Ratio	Session Four (n=3) Ratio
Relevance	0.53	-0.25	0.02	0.33
Importance	1.00	0.67	1.00	1.00
Novelty	-0.39	-0.56	0.08	-0.78
Ambiguity	0.80	1.00	0.25	0.60
Outside Knowledge	1.00	0.00	0.00	1.00
Linking Ideas	0.78	1.00	1.00	1.00
Justification	-0.08	0.71	-0.08	0.00
Critical Assessment	0.76	1.00	1.00	1.00
Practical Utility	0.60	1.00	1.00	1.00
Width of Understanding	0.00	0.00	0.00	0.00

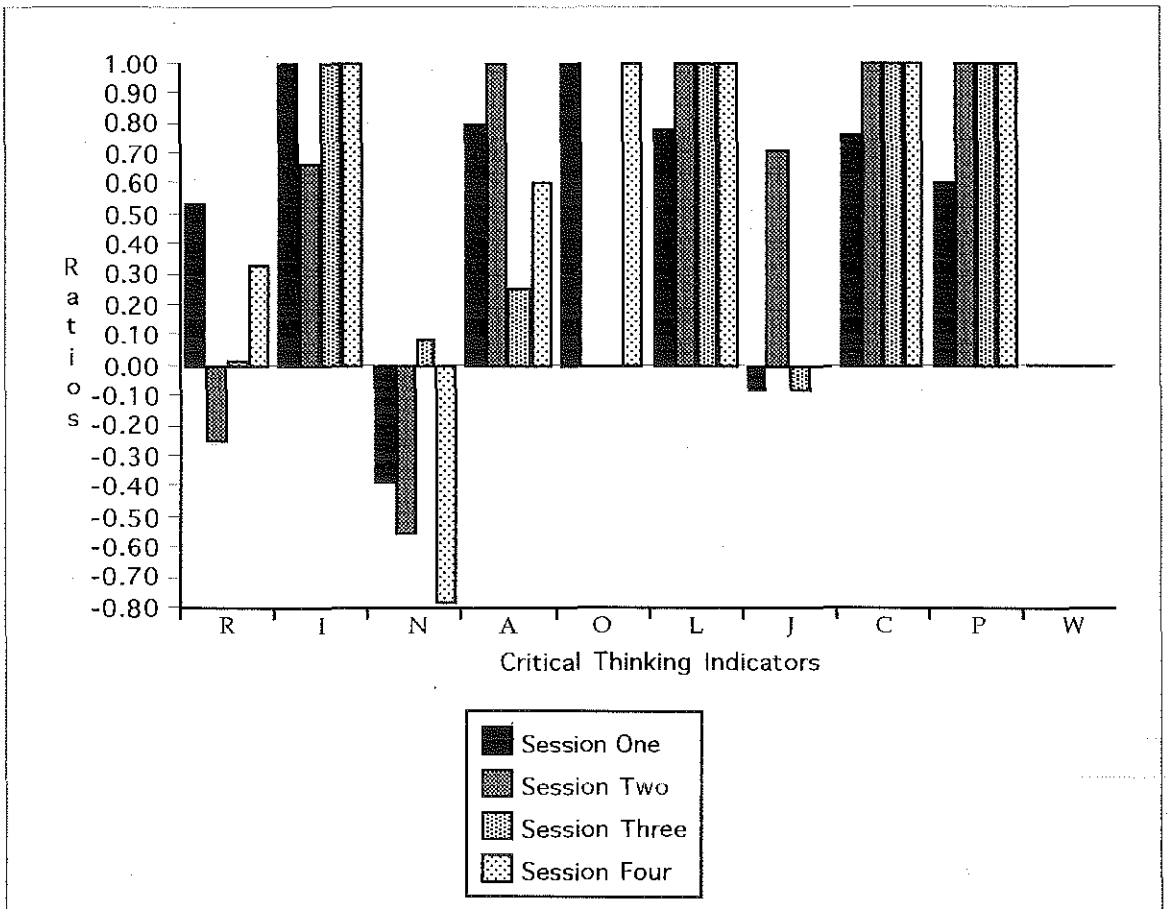

Figure 4. Girls' critical thinking indicator ratios identified in 4, 1 hour sessions using Encarta

Table 8 and Figure 5 show the boys' and girls' Relevance indicators over the four sessions. The boys' results show a variable spread of ratios from the first to the last session. Within the first session the boys scored a positive ratio of 0.52 indicating critical thinking for this indicator at the beginning of this study. This ratio declined for the second session but remained positive. By the third session the boys' Relevance ratio increased beyond the original ratio in session one to 0.80 and then dropped to a negative ratio, indicating non-critical thinking, in the fourth session. There was no consistent development in Relevance for boys since the ratios

fluctuated and the fourth Relevance ratio was lower than the one obtained in session one.

The Relevance indicators identified for girls show a positive ratio in the first session indicating critical thinking for this skill at the beginning of this study. This ratio declined to a negative (non-critical thinking) score in session two. In session three the results increased to a low positive ratio with a further increase in session four. There was no consistent development in Relevance for girls since ratios fluctuated and the fourth Relevance ratio was lower than the one obtained in session one.

Table 8.

Boys' and girls' Relevance indicator ratios identified in four sessions using Encarta

Session	Boys (n=3) Ratio	Girls (n=3) Ratio
One	0.52	0.53
Two	0.20	-0.25
Three	0.80	0.02
Four	-0.02	0.33

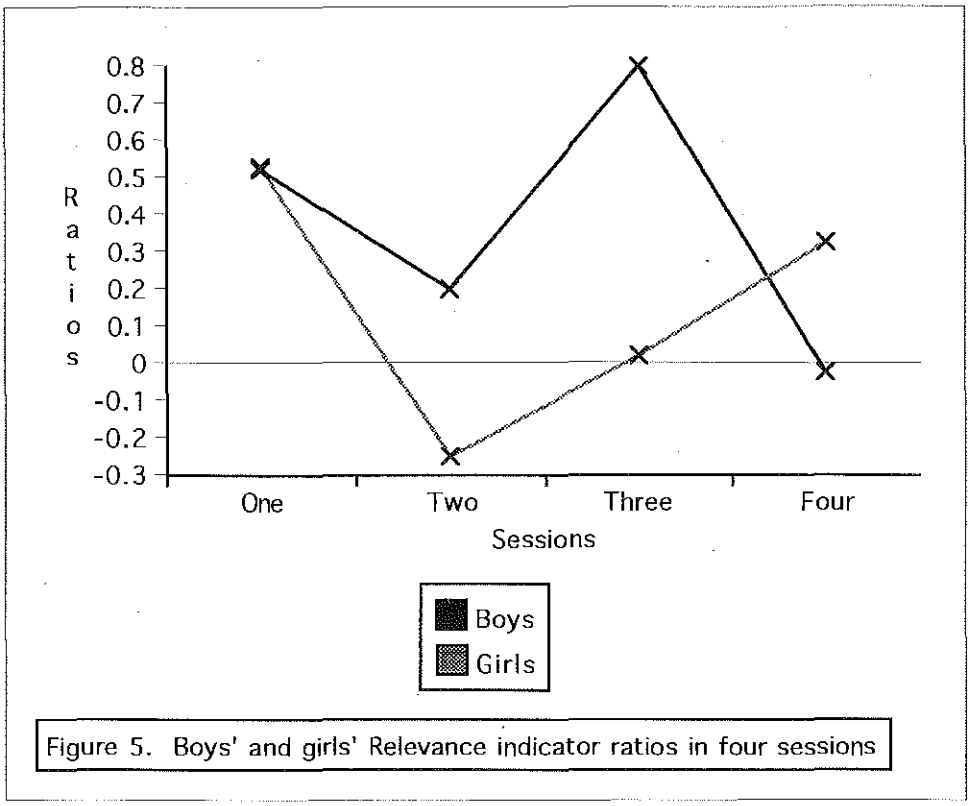

Figure 5. Boys' and girls' Relevance indicator ratios in four sessions

Table 9 and Figure 6 show the boys' and girls' Importance indicators over the four sessions. The boys' results show consistent high positive ratios from the first to the last session. Within the first session the boys scored a positive ratio of 0.78 indicating critical thinking for this indicator at the beginning of this study. This ratio increased to 1.00 which was maintained for the subsequent three sessions. There was a consistent development in Importance for boys.

The Importance indicators identified for girls show a positive ratio of 1.00 in the first session indicating a maximum score for this critical thinking skill at the beginning of this study. This ratio declined in the second session but remained positive. In session three and four the ratios reverted to ratios

of 1.00. There was no consistent development in Importance for girls since ratios fluctuated.

Table 9.

Boys' and girls' Importance indicator ratios identified in four sessions using Encarta

Session	Boys (n=3) Ratio	Girls (n=3) Ratio
One	0.78	1.00
Two	1.00	0.67
Three	1.00	1.00
Four	1.00	1.00

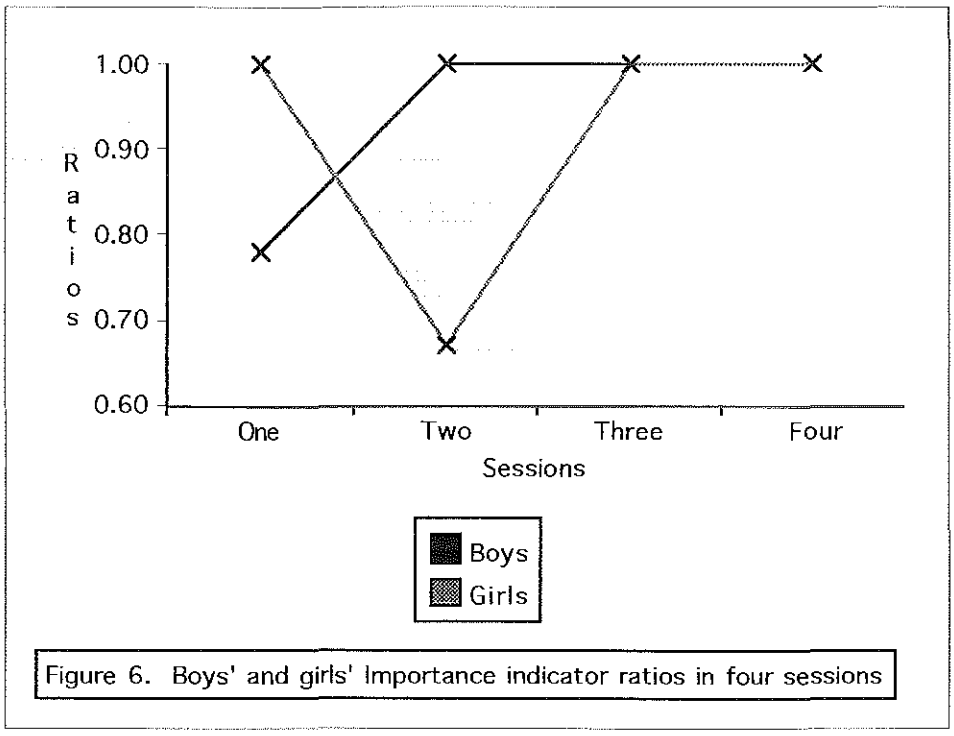

Figure 6. Boys' and girls' Importance indicator ratios in four sessions

Table 10 and Figure 7 show the boys' and girls' Novelty indicators over the four sessions. The boys' results show a variable spread of ratios from the first to the last session. Within the first session the boys scored a low positive ratio of 0.11 indicating critical thinking for this indicator at the beginning of this study. This ratio declined for the second session scoring a negative ratio. By the third session the boys' Novelty ratio increased but maintained a negative ratio and then decreased further indicating that there was non-critical thinking in the final three sessions. There was no consistent development in Novelty for boys since the ratios fluctuated and the fourth Novelty ratio was lower than the one obtained in session one. But there was an important decline in this indicator.

The Novelty indicators identified for girls show a negative ratio in the first session indicating non-critical thinking for this skill at the beginning of this study. This ratio declined further in session two. In session three the results increased to a low positive ratio indicating critical thinking but declined to negative ratio in session four. There was no consistent development in Novelty for girls since ratios fluctuated and the fourth Novelty ratio was lower than the one obtained in session one. But, as with the boys, and almost following the same pattern, there was an important decline in this indicator.

Table 10.

Boys' and girls' Novelty indicator ratios identified in four sessions using Encarta

Session	Boys (n=3) Ratio	Girls (n=3) Ratio
One	0.11	-0.39
Two	-0.40	-0.56
Three	-0.16	0.08
Four	-0.67	-0.78

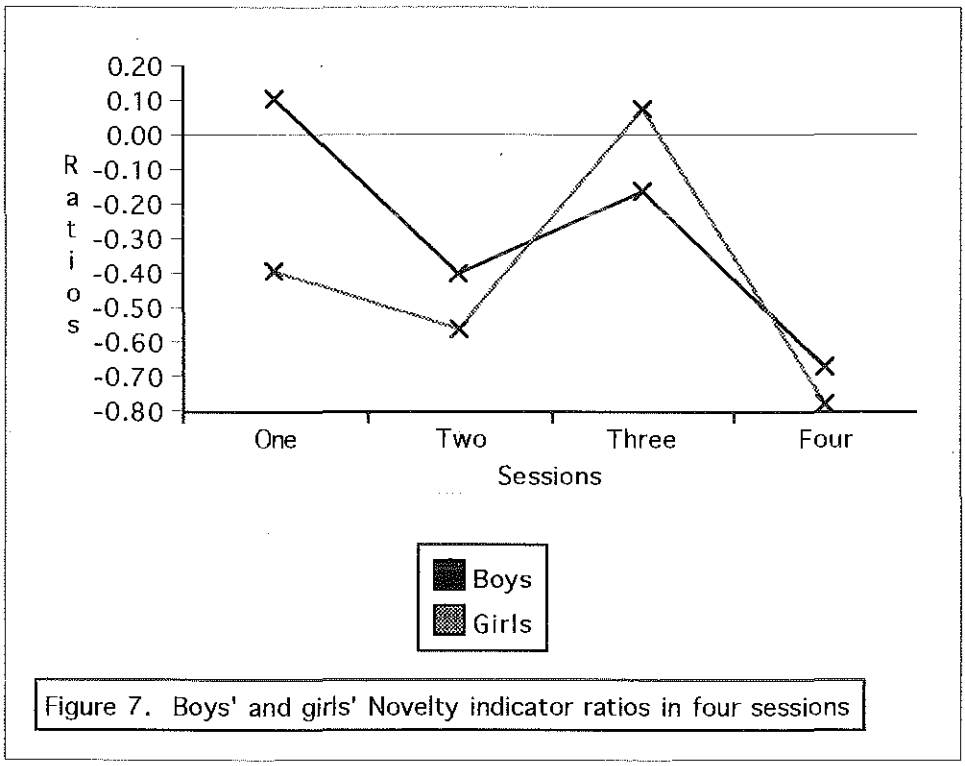

Figure 7. Boys' and girls' Novelty indicator ratios in four sessions

Table 11 and Figure 8 show the boys' and girls' Ambiguity indicators over the four sessions. The boys' results show consistent 1.00 ratios in the first three sessions indicating critical thinking for this indicator at the beginning of this study. This ratio declined in the fourth session but remained positive. These results show that there was critical thinking throughout the

four sessions for this indicator but there was no consistent development in Ambiguity for boys since the fourth Ambiguity ratio was lower than the one obtained in session one.

The Ambiguity indicators identified for girls show a variable spread of ratios from the first to the last session. In the first session the Ambiguity ratio was 0.80. This ratio increased to a perfect 1.00 in session two. In session three the results decreased to a low positive ratio and then increased in session four. There was no consistent development in Ambiguity for girls since ratios fluctuated and the fourth Ambiguity ratio was lower than the one obtained in session one.

Table 11.

Boys' and girls' Ambiguity indicator ratios identified in four sessions using Encarta

Session	Boys (n=3) Ratio	Girls (n=3) Ratio
One	1.00	0.80
Two	1.00	1.00
Three	1.00	0.25
Four	0.33	0.60

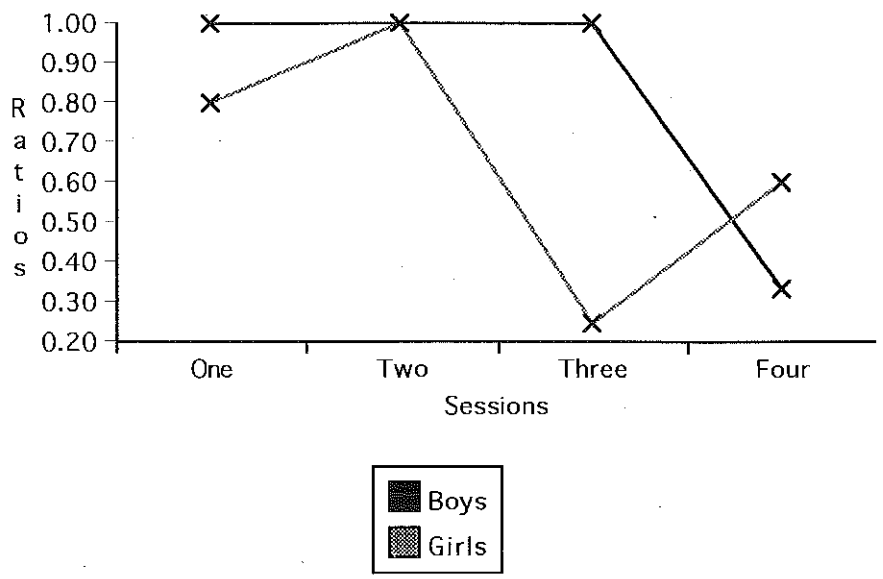

Figure 8. Boys' and girls' Ambiguity indicator ratios in four sessions

Table 12 and Figure 9 show the boys' and girls' Outside Knowledge indicators over the four sessions. The boys' results show consistent 1.00 ratios in the four sessions indicating consistent critical thinking for this indicator throughout this study.

The Outside Knowledge indicators identified for girls show a variable spread of ratios from the first to the last session. In the first session the Outside Knowledge ratio was 1.00. This ratio decreased to 0.00 in session two and remained so for session three. In session four the ratio reverted to 1.00. There was no consistent development in Outside Knowledge for girls since ratios fluctuated.

Table 12.

Boys' and girls' Outside Knowledge indicator ratios identified in four sessions using Encarta

Session	Boys (n=3) Ratio	Girls (n=3) Ratio
One	1.00	1.00
Two	1.00	0.00
Three	1.00	0.00
Four	1.00	1.00

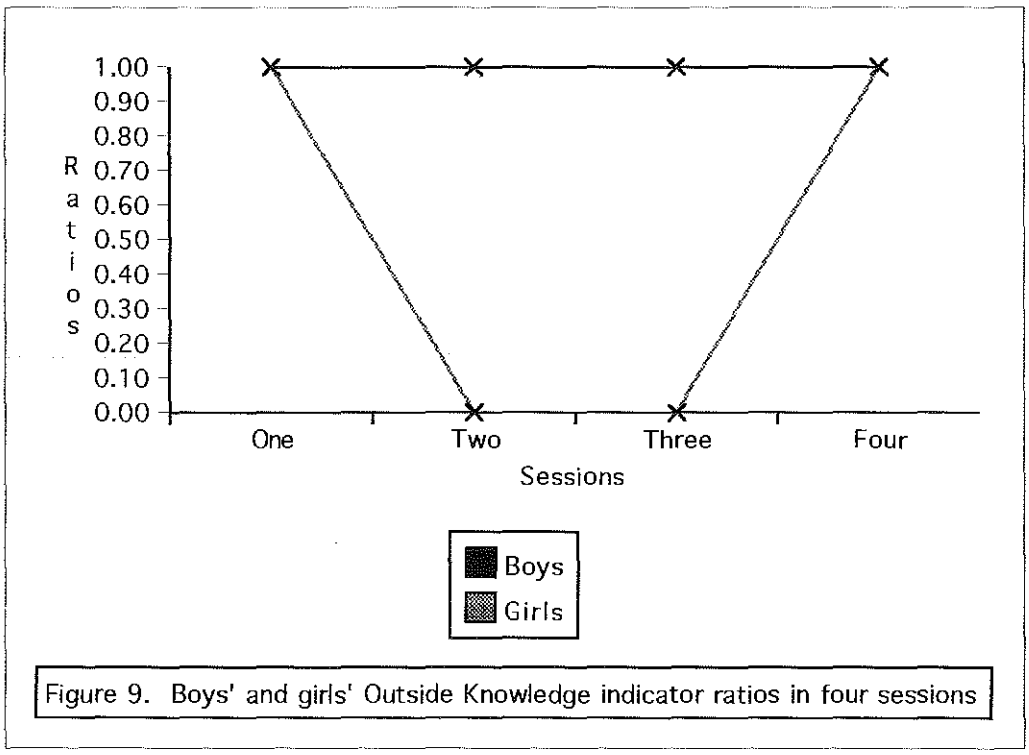

Figure 9. Boys' and girls' Outside Knowledge indicator ratios in four sessions

Table 13 and Figure 10 show the boys' and girls' Linking Ideas indicators over the four sessions. The boys' results in the first session show a ratio of 0.38 indicating critical thinking for this indicator at the beginning of this study. This ratio increased in the subsequent session to 1.00 which was maintained for the three final sessions. These results show that there was

critical thinking throughout the four sessions for this indicator and there was consistent development in Linking Ideas for boys since the fourth ratio was higher than the one obtained in session one.

The girls' Linking Ideas indicators in the first session show a ratio of 0.78 indicating critical thinking for this indicator at the beginning of this study. This ratio increased in the subsequent session to 1.00 which was maintained for the three final sessions. These results show that there was critical thinking throughout the four sessions for this indicator and there was consistent development in Linking Ideas for girls since the fourth ratio was higher than the one obtained in session one.

Table 13.

Boys' and girls' Linking Ideas indicator ratios identified in four sessions using Encarta

Session	Boys (n=3) Ratio	Girls (n=3) Ratio
One	0.38	0.78
Two	1.00	1.00
Three	1.00	1.00
Four	1.00	1.00

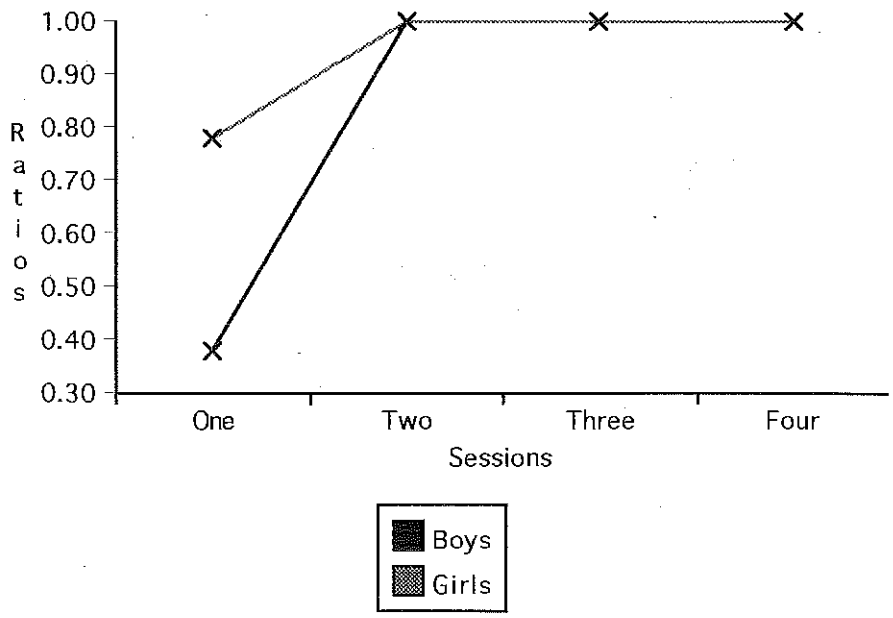

Figure 10. Boys' and girls' Linking Ideas indicator rations in four sessions

Table 14 and Figure 11 show the boys' and girls' Justification indicators over the four sessions. The boys' results show -0.25 in the first session indicating non-critical thinking for this indicator at the beginning of this study. This ratio was maintained in the second session. In session three the Justification ratio increased but decreased in session four. Throughout the study the ratios for this indicator remained negative indicating that there was no non-critical thinking for this indicator. There was no consistent development in Justification for boys since the ratios were negative, they fluctuated and the fourth Justification ratio was lower than the one obtained in session one.

The Justification indicators identified for girls show a variable spread of ratios from the first to the last session. In the first session the Justification ratio was -0.08 indicating non-critical thinking at the beginning of the study. This ratio increased to a positive ratio in session two. In session three the results decreased to a negative ratio and then increased to 0.00 in session four. There was no consistent development in Justification for girls since ratios fluctuated and the fourth Justification ratio, although higher than the first ratio, scored 0.00 in the final session.

Table 14.

Boys' and girls' Justification indicator ratios identified in four sessions using Encarta

Session	Boys (n=3) Ratio	Girls (n=3) Ratio
One	-0.25	-0.08
Two	-0.25	0.71
Three	-0.08	-0.08
Four	-0.29	0.00

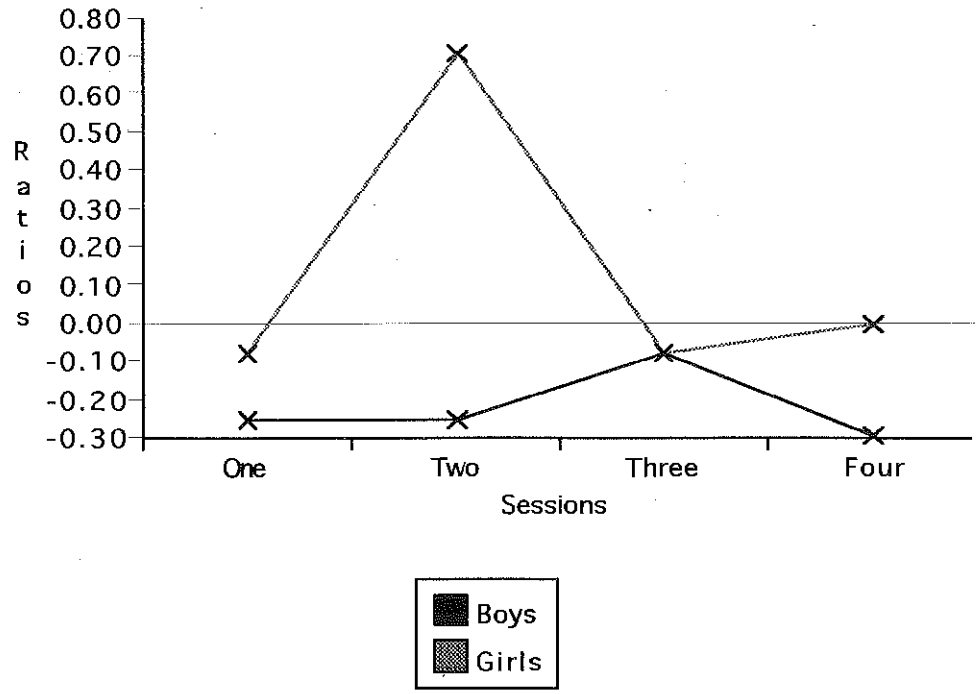

Figure 11. Boys' and girls' Justification indicator ratios in four sessions

Table 15 and Figure 12 show the boys' and girls' Critical Assessment indicators over the four sessions. The boys' results in the first session show a ratio of 0.85 indicating critical thinking for this indicator at the beginning of this study. This ratio increased in the subsequent session to 1.00 which was maintained for the three final sessions. These results show that there was critical thinking throughout the four sessions for this indicator and there was consistent development in Critical Assessment for boys since the fourth ratio was higher than the one obtained in session one.

The girls' Critical Assessment indicators in the first session show a ratio of 0.76 indicating critical thinking for this indicator at the beginning of this study. This ratio increased in the subsequent session to 1.00 which was

maintained for the three final sessions. These results show that there was critical thinking throughout the four sessions for this indicator and there was consistent development in Critical Assessment for girls since the fourth ratio was higher than the one obtained in session one.

Table 15.

Boys' and girls' Critical Assessment indicator ratios identified in four sessions using Encarta

Session	Boys (n=3) Ratio	Girls (n=3) Ratio
One	0.85	0.76
Two	1.00	1.00
Three	1.00	1.00
Four	1.00	1.00

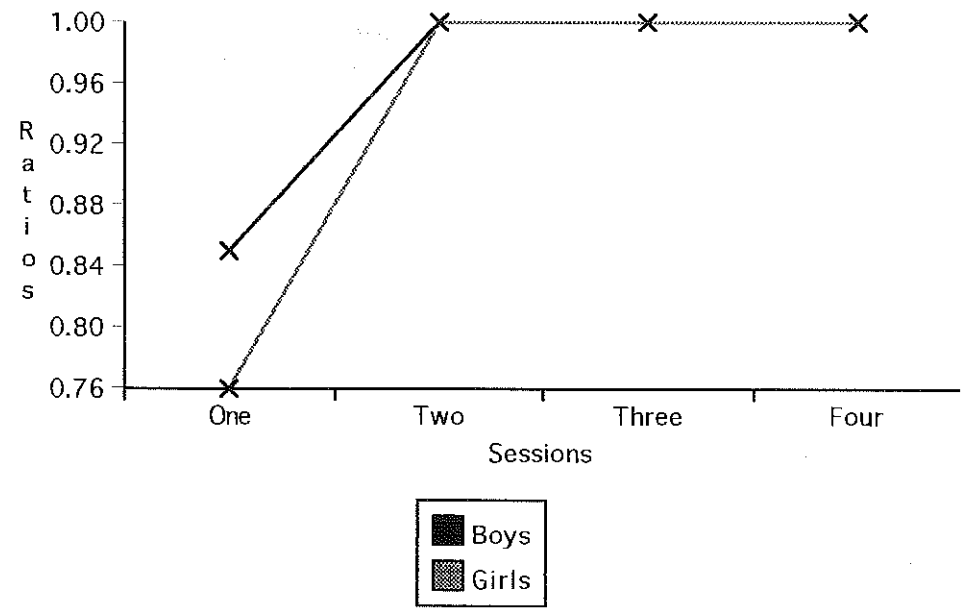

Figure 12. Boys' and girls' Critical Assessment indicator ratios in four sessions

Table 16 and Figure 13 show the boys' and girls' Practical Utility indicators over the four sessions. The boys' results in the first session show a ratio of -1.00 indicating non-critical thinking for this indicator at the beginning of this study. This ratio increased in the subsequent session to 1.00 which was maintained for the three final sessions. These results show that there was critical thinking throughout the four sessions for this indicator and there was consistent development in Practical Utility for boys since the fourth ratio was higher than the one obtained in session one.

The girls' Practical Utility indicators in the first session show a ratio of 0.60 indicating critical thinking for this indicator at the beginning of this study. This ratio increased in the subsequent session to 1.00 which was maintained for the three final sessions. These results show that there was critical thinking throughout the four sessions for this indicator and there was consistent development in Practical Utility for girls since the fourth ratio was higher than the one obtained in session one.

Table 16.

Boys' and girls' Practical Utility indicator ratios identified in four sessions using Encarta

Session	Boys (n=3) Ratio	Girls (n=3) Ratio
One	-1.00	0.60
Two	1.00	1.00
Three	1.00	1.00
Four	1.00	1.00

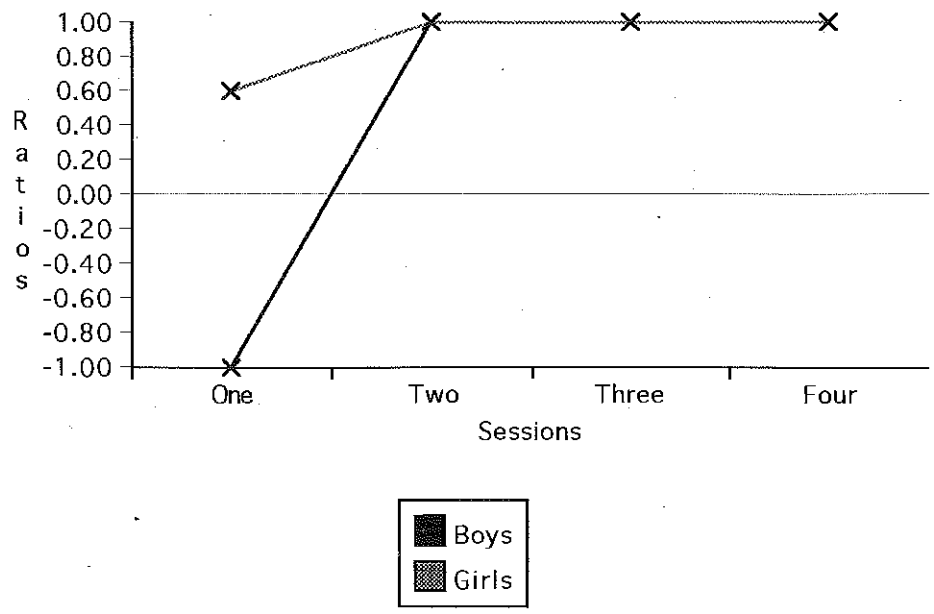

Figure 13. Boys' and girls' Practical Utility indicator ratios in four sessions

Table 17 shows the boys' and girls' Width of Knowledge indicators over the four sessions. No indicators were identified in either group's verbal interactions.

Table 17.

Boys' and girls' Width of Knowledge indicator ratios identified in four sessions using Encarta

Session	Boys (n=3) Ratio	Girls (n=3) Ratio
One	0.00	0.00
Two	0.00	0.00
Three	0.00	0.00
Four	0.00	0.00

Field notes identifying critical thinking when using Encarta

The field notes obtained during the four sessions for each group were compiled according to the following Encarta features specified in Table 3.

Selection, control and pacing. The Encarta package allowed each of the groups to have constant and total freedom to work at their own pace by selecting their pathway using the thousands of cards available. Selections were mainly made using the mouse, with occasional use of the keyboard to type in key words for searches.

The person holding the mouse played a significant role in the pacing of the groups learning since the person controlling the mouse controlled the pace of movement between cards and features within Encarta. The person controlling the keyboard controlled what was written. Students took turns using the mouse and keyboard. Selection of information and features was decided collectively by each group based on the questions presented.

By the fourth session, the boys were using more shortcuts available in Encarta such as the Outline which allows the user to scan the headings contained within the present accessed card. This feature gave the boys an opportunity to discuss critically what they should look at and to justify their choices.

By the third session the girls were using more facilities available in Encarta. However, the facility Go Back posed some problems for the girls and made it difficult for the girls to find one of the previous cards they had accessed. In the end, they used Contents to find the desired card.

Hypertext / hyperlinks: Throughout the four sessions students generally chose to perform searches for task related information using the Contents or Find features. The boys did not use hyperlinks at all. In session three the girls tried to use hot spots on a map but it did not have any. In session four, the girls began to use hyperlinks using the blue text on the screen to access another related card. Initially this allowed the girls to gather more information but then as they moved away from their topic they entered an irrelevant screen and confused American Indian dialects with Indian dialects without being aware of it.

All forms of media found Students in both groups relied heavily on the text found within Encarta. Throughout the four sessions the boys would scan the text within Encarta using a keyword search, copy large sections of the text from Encarta directly into the word processor and then reword the text. The girls would search and read large sections of the text and then make notes in the note pad or compose their responses directly within the word processor. Graphics such as graphs were overlooked by students. Students tried to copy pictures but found that there was not enough memory available.

In session four the boys began to use graphics such as maps to gather information and to clarify understandings. The girls used the information from a table to locate other information by identifying some endangered species that were represented in a graph. However, when the girls looked at a photograph of a snow leopard they did not use any information to form descriptions to use in their response.

A map was used in session three to locate information about Mayans. In session four the girls spent about 10 minutes listening to phrases spoken in Hindi and Urdu by the computer. They repeated these phrases and were very amused by this feature. However, the sounds were not relevant to the task they were doing and hence distracted the students from their work.

Encarta Highlights Encarta Highlights was only used by the students and researcher during the introduction to Encarta.

Note pad and word processor The boys automatically copied information from one card in Encarta straight into the word processor and then reworded the text, after which the information from Encarta was deleted. At no time during the four sessions did the boys use the note pad. The computer voice within the word processor was used to read each group's work. However, this feature was only used twice by each group since the sound quality was very poor, and was used more as a source of amusement than to improve their work.

Within the word processor, both groups used a great deal of changing surface features such as punctuation, spelling, and grammar of the document. Boys took turns typing but did not share ideas before typing. One person typed, the other two checked text and pointed out surface errors.

The word processor feature was used by students to review their work from the previous session but few changes were made. When making corrections boys used the mouse to directly point to the text that needed changing. The teacher needed to direct students to reread their whole answer to review their final response. Boys expressed the need for a thesaurus, dictionary and spell check in the word processor.

In the third session the boys were beginning to check whether they were answering the question as well as surface features. The boys still used text from Encarta but began to make their own links between points, copying phrases from Encarta to add and support their own response rather than whole blocks of text.

From session one, the girls used the word processor to make brief notes on their previous knowledge of the topic before they entered Encarta. They also used the note pad to copy short blocks of text from Encarta which they would then copy into the word processor. The girls would have preferred to have a global note pad available at any time within Encarta rather than having to attach separate notes to specific cards.

As with the boys, the girls were concerned with the surface features of their document making numerous changes to the font and style of the text. Although all the students enjoyed making these text changes a large amount of time was wasted on this exercise.

The girls used the word processor to critically assess what they had typed, rereading their work a number of times and discussing the contents as well as making surface changes. This strategy was employed throughout the four sessions and allowed the girls to engage in extensive discussions to identify a number of instances where inconsistencies arose and to think critically about their response.

By session three the girls had abandoned the note pad and copied short blocks of text directly into the word processor. This was continued in session four making the note pad obsolete.

Contents keyword search This feature was not used by the boys in any session. The girls used Contents to perform all their searches and were using shortcuts from the first session.

Category Browser This feature was not used by the boys in the first and third sessions. In the second session the boys used the category geography to look up environment. This tended to direct the boys on an unrelated pathway and they ended up looking at penguins. The girls did not use this feature.

Gallery Wizard/Find Wizard This feature was not used by the boys in the first and third sessions. In the second session the students used the gallery wizard to find pictures. This made their collection of information difficult since they looked for any pictures contained within Encarta and so distracted them from the task they were trying to complete. The girls did not use this feature.

Students' Word Processed Responses to Complex Tasks

Each group of students responded to the complex tasks using the word processor provided within Encarta. (See Appendix E for examples of boys' and girls' responses to tasks.) The responses contained text only with no reference being made to any of the other forms of media. Attempts were made by the students to copy photographs and graphics into their documents but this was not possible due to the limited memory capacity of the computer used.

With regard to the depth of students' responses the boys produced more detailed responses to the tasks than the girls. The boys responses largely contained reworded text from Encarta following a similar content structure found in Encarta. The girls tended to use their own ideas and words expanding and clarifying concepts using examples from Encarta.

Conclusions

The major conclusions drawn from this study are as follows for the content analysis technique, field notes, and students' word processed responses.

Seven of the ten critical thinking indicators: Relevance, Importance, Outside Knowledge, Ambiguities, Linking Ideas, Critical Assessment, and Practical Utility obtained positive scores, demonstrating critical thinking in these areas by the six students in the study. The other three critical thinking indicators which showed non-critical thinking were Novelty, Justification and Width of Knowledge.

Of the seven critical thinking indicators which had positive ratios, Linking Ideas, Critical Assessment and Practical Utility demonstrated and maintained development over the four sessions for both boys and girls, with the boys also demonstrating development in the area of Importance.

The remaining critical thinking indicators, Relevance, Outside Knowledge and Ambiguities, demonstrated variable ratio scores showing inconsistent development throughout the study due to the fluctuating scores.

Hypertext/Hyperlinks caused the students to become confused and retrieve irrelevant information. The word processor was used extensively by the boys to copy blocks of text from Encarta which they subsequently reworded to form their own response to the task. The girls used the word

processor to perform a range of jobs, from using it as a note pad for ideas to formulating their final response to the task. Once direct copying was established between Encarta and the word processor, the note pad became obsolete.

Boys responses to tasks were more detailed comprising mainly of reworded information from Encarta. Girls responses reflected their own understandings and sequence of ideas which were supported by information from Encarta.

CHAPTER 7

Discussion

This chapter discusses the results presented in Chapter 6 and the implications of these findings for the use of Multimedia Information Systems to support the development of critical thinking skills. Based on these findings, recommendations are made for further research. The discussion is presented in the form of responses to each of the research questions.

1. What critical thinking skills do students use when using a MIS?

This study has shown that when the students were engaged in open-ended complex tasks executed using the MIS package Encarta a number of critical thinking indicators were evident in the groups' verbal interactions. Over the four sessions both groups collectively scored a positive or negative mean ratio for each of the ten indicators except Width of Knowledge for which there was no score.

There was evidence, in the nine remaining indicators, of critical thinking. However, for many of the indicators evidence was variable, and did not demonstrate consistent use of critical thinking. Relevance, Novelty, Ambiguities and Justification obtained fluctuating scores for both boys and

girls, with girls also demonstrating variable scores for Importance and Outside Knowledge.

Consistent scores were obtained for Linking Ideas, Critical Assessment and Practical Utility for both boys and girls, with boys also demonstrating consistency in Importance and Outside Knowledge.

The indicators that the six students used most over the four sessions were Importance, Linking Ideas, and Critical Assessment scoring a mean ratio of 0.93, 0.90, and 0.95 respectively. The results from this study reflect those obtained by Newman, Webb, Cochrane, (1995) who found that Importance and Linking Ideas consistently obtained more positive ratios for the university students' discussions, which focused on contentious open-ended issues in information technology to stimulate critical thinking. There were also clear signs in the data, that these indicators scored highly for both groups, as a result of the use of particular features in Encarta.

2. Does experience influence the critical thinking skills demonstrated by students using a MIS ?

This study has shown that within the boys' group the critical thinking indicators that develop over a short time when using a MIS are Importance, Linking Ideas, Critical Assessment and Practical Utility. Interestingly a consistent pattern occurred in these critical thinking indicators for the boys' group. In the first session these indicators from Table 5 scored 0.78, 0.38, 0.85 and -1.00 respectively; then in the subsequent three sessions each of these four indicators scored a 1.00.

With regard to the girls' group, the critical thinking indicators that developed over time when using a MIS were Linking Ideas, Critical Assessment and Practical Utility. Once again a consistent pattern occurred in these critical thinking indicators. In the first session these indicators scored 0.78, 0.76, and 0.60 respectively; then in the subsequent three sessions each of these three indicators scored a 1.00.

It would seem from these results that students may have already possessed these critical thinking skills in varying degrees before this study and were able to increase and maintain a high performance in subsequent sessions due to practice. However, it is also possible that this developmental effect in these particular indicators was due to both the use of particular features in Encarta, and to high levels of verbal interaction within the groups.

This study has focused on the critical thinking skills students use and develop over a short time. Results show that some critical thinking indicators are evidenced in the completion of complex tasks over a short time. However, it is recommended that teachers develop strategies to support the development of critical thinking in students in the use of MIS; and in particular, to develop those skill elements that both this study and that of Newman, Webb and Cochrane (1995), have found to be missing or minimal in students' thinking, namely width of knowledge and justification.

It is recommended that teachers give their students ample opportunity to develop the necessary skills to operate MIS packages such as Encarta effectively and effortlessly, since this gives students more freedom to engage in higher level thinking and hence use all elements of critical thinking extensively, rather than just Importance, Linking Ideas, Critical Assessment and Practical Utility, as seen in this study.

With regard to the choice of MIS, it is recommended that the package allows the use of a wide range of media forms within the word processor. Also that the word processor has sophisticated facilities such as a spell check, thesaurus, and dictionary. Within the features of Encarta cards, an easy search facility to locate specific word within the text would be useful for users who do not wish to read or scan endless screens of scrolled text.

This is particularly true for those users who access a particular card a number of times to seek different pieces of information and do not wish to copy large blocks of text.

This study has been necessarily limited in scope and design. It is recommended that a similar study is performed on a range of ability levels rather than just high ability students. The task used for the study should be project based rather than open-ended questions to encourage students to gather a wider range of information supported with a range of media forms. Furthermore, this study should be carried out over a longer period of time to give students the opportunity to master all the facilities available within Encarta as well as to examine whether extended exposure to this MIS develops critical thinking skills in students to a greater extent than seen here.

This was an exploratory study, to identify and describe the critical thinking skills evident in young students' use of Encarta over a short time frame. It would be of value to conduct an experimental study, based on the findings here, to determine more clearly, a comparison of critical thinking skills developed in students over time, when using an MIS such as Encarta, or gathering information to complete a complex task - such as use of paper-based encyclopaedia.

In conclusion, the results of this study show that the critical thinking indicators Relevance, Importance, Ambiguity, Outside Knowledge, Linking

Ideas, Critical Assessment and Practical Utility were used in both groups over the four sessions to respond to complex tasks based on the use of Encarta. Importance, Linking Ideas, Critical Assessment and Practical Utility were the highest scoring indicators for the groups of six students, as well as within their individual groups throughout the four sessions.

However, it is necessary that teachers provide students with ample time to master the operation of the MIS package and to use it to respond to project based tasks. Teachers should also develop justification skills and the ability to search for a wide range of knowledge to empower their students to develop use of the full range of critical thinking skills.

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APPENDIX A

CONTENT ANALYSIS TECHNIQUE

Indicators of critical thinking

R+- Relevance
- R+ relevant statements
- R- irrelevant statements, diversions

I+- Importance
- I+ important points/issues
- I- unimportant, trivial points/issues

N+- Novelty. New info, ideas solutions
- NP+ New problem-related information
- NP- Repeating what has been said
- NI+ New ideas for discussion
- NI- False or trivial leads
- NS+ New solutions to problems
- NS- Accepting first offered solution
- NQ+ Welcoming new ideas
- NQ- Squashing, putting down new ideas
- NL+ learner (student) brings new things in
- NL- dragged in by tutor

O+- Bringing outside knowledge/experience to bear on problem
- OE+ drawing on personal experience
- OC+ refer to course material
- OM+ use relevant outside material
- OK+ evidence of using previous knowledge
- OP+ course related problems brought in
- OQ+ welcoming outside knowledge
- OQ- squashing attempts to bring in outside knowledge
- O- sticking to prejudice or assumptions

A+- Ambiguities: clarified or confused
- AC+ clear, unambiguous statements
- AC- confused statements
- A+ discuss ambiguities to clear them up
- A- continue to ignore ambiguities

L+- Linking ideas, interpretation

- L+ linking facts, ideas and notions
- L+ generating new data from information collected
- L- repeating information without making inferences or offering an interpretation
- L- stating that one shares the ideas or opinions stated, without taking these further or adding any personal comments

J+- Justification

- JP+ providing proof or examples
- JS+ justifying solutions or judgments
- JS+ setting out advantages and disadvantages of situation or solution
- JP- irrelevant or obscuring questions or examples
- JS- offering judgments or solutions without explanation or justification
- JS- offering several solutions without suggesting which is the most appropriate

C+- Critical assessment

- C+ critical assessment/evaluation of own or others' contributions
- C- uncritical acceptance or unreasoned rejection
- CT+ tutor prompts for critical evaluation
- CT- tutor uncritically accepts

P+- Practical utility

- P+ relate possible solutions to familiar situations
- P+ discuss practical utility of new ideas
- P- treat in a vacuum
- P- suggest impractical solutions

W+- Width of understanding

- W- narrow discussion
- W+ widen discussion

+ (critical thinking) - (uncritical thinking)

(Newman, Webb & Cochrane, 1995, p 68-69)

APPENDIX B

ENCARTA

Features of Encarta

Encarta Highlights

Features:

- photos, text, sound (speech), buttons
- examples of different languages - audio, directions (text) how to locate (simple to understand)
- topics - text and photo examples of people
- atlas
- sports
- orbit simulation
- visual arts
- music - jazz
- video
- illustrated time line
- writers and poets (audio gives correct intonation to gain more meaning from poetry and literature)
- animations - complex processes made simple and understandable
- details on US
- animals of the world - sound, visual, text
- historical maps - location of history
- human body - journey through body
- world music
- mind maze - answering questions to find information (independent or against friends)
- wonders of nature - photos of mountains, forests, glaciers
- slide show - picture, sound, maps, charts, tables, animation, video, (can be viewed or created)

Contents

- A-Z library, lists topics A-Z
- spell check
- help facility - short instruction to assist with use of contents
- clicking on a letter directs lists of topics beginning with the letter.

Category Browser

Allow searches using area of interest and category

Area of interest:
- physical science and technology
- life science
- geography
- history
- social science
- religion and philosophy
- art, language, and literature
- performing arts
- sports, games, hobbies and pets

Category:
- each interest area has specific categories

Find Wizard (Gallery Wizard)

Search for:
- word
- topic
- gallery items
- year/time
- biographies

Enter Encarta

Screen:
- buttons: contents, find, game, gallery, atlas, timeline, go back, A-Z, help.
- Title - graphics, list (topics), category, < >
- text - blue text, can move to that topic to link information
- photos
- camera icon - photo and/or caption
- go to topic - move to related information
- print text
- outline - lists headings of text

Bar menu:
- File: - options, title screen, sound setup
- Features: - title screen, book list, bookmark, create note, dictionary, word processor, mind maze game.
- Navigate

APPENDIX C

TASKS

Students are encouraged to use all forms of media to respond to the following tasks:

Sample task

To discover the important role the ozone layer plays in our environment.

Q. Is there a need to be concerned about the ozone layer ?

Individual tasks for each sessions

Task 1: To discover that animals depend on their environment for survival.

Why and how do we need to conserve the environment for animals as well as ourselves ? Explain your answer using an example of an animal.

Task 2: To discover that change occurs in all societies and cultures.

Does the way Mayans once lived differ from our own lifestyle ? Explain your answer.

Task 3: To discover the necessity for a healthy lifestyle to sustain good health.

Smoking, what's all the fuss about ?

Task 4: To discover the significance of law and order in the community.

Is punishment really necessary in society today ?

Task 5: To discover the necessity for technology in adapting to, modifying and utilising the natural environment.

Is it necessary to have flood control such as the one found in the Netherlands ? Explain your answer.

APPENDIX D

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH

TITLE: Developing and measuring students' critical thinking when using a Multimedia Information System (MIS)

This study is concerned with the role multimedia information systems, such as Encarta, play in developing critical thinking skills. Students need problem solving skills to construct their knowledge. Therefore, this study aims to determine: what critical thinking skills students use and develop over time; and what features of MIS support the development of those skills while using Encarta.

This study will require five, one hour, sessions conducted during school hours at St Columba's Catholic Primary School.

The benefits to the student include the opportunity to use and develop their critical thinking skills using current computer software in a cooperative group setting. In turn, this will assist teachers to focus on the thinking skills which are necessary to think critically when using a MIS such as Encarta, while influencing future educational software development by identifying the features which support the development of critical thinking.

Any questions concerning the project entitled 'Developing and measuring students' critical thinking when using a Multimedia Information System' can be directed to Maria Lipiec, [redacted]

I _____, have read the information above and any questions I have asked have been answered to my satisfaction. I give permission for my child, _____ to participate in this activity, realising I may withdraw him/her at any time.

I agree that the research data gathered for this study may be published provided my child is not identifiable.

_____

Parent/Guardian Date

_____

Investigator Date

APPENDIX E

Example of boys' word processed response to a complex task

CONSERVATION OF LAND AND ANIMALS

The Tasmanian Devil was a native creature of Tasmania. It was the victim of many hunters, including humans and animals. It is a good example of what we (humans) have done to nature. Humans should learn from this; and in the future we should protect and conserve nature, so future generations can see these animals. The Tasmanian Devil is an animal about the size of a badger. It's fur was black to brown in colour.

The Bandicoot is an endangered species of the world. Many organisations have planned to conserve the Bandicoot by placing them in a cage. They put forwad a program to breed the Bandicoots. However, the operation was unsuccessful.

We need to conserve the enviroment so the animals can have a place to live. If this was not so, all the animals would eventually die out. If all the animals did die out, humans would have hardly any food source; because meat is an essential part of the human diet.

The main reason to conserve the environment is because of our need and the animals need of oxygen. Another reason to conserve the environment is because animals need a place to live, and without these places, they would die.

Many organisations have planned to conserve nature by protecting animals in confined areas. The organisations have raised arguments about the amount of chemicals and toxic waste that industries have been using.

Some of these organisations have successfully prevented nature from being destroyed.

An example of this, is the mining company called ALCOA. This company has prevented the environment from being totally annhiallated. They have done this by doing environmental impact studies before they start mining a particular site. In the

environmental impact study the company thinks about the consequences of the environment; they think about if any chemicals will affect any water. A good example would be a nearby dam. After the mine site has been mined, they go through a rehabilitation process. This process involves planting new trees and placing the original animals into their reconstructed habitat.

We humans need to preserve our native flora and fauna. We need to do this because all the food that we eat comes from our environment. Without a suitable environment humans would not exist. Many humans have cut down trees of many different animals, which has ruined their habitat. This has caused the major downfall of many species of animal.

Humans conserve animals because they excrete materials that are high in nutrients. These nutrients penetrate the soil giving off nutrients that are vital for plants.

Example of girls' word processed response to a complex task

Conserving The Environment

Dying is part of the process of evolution. But we still need to conserve the environment for animals as well as ourselves, otherwise there would not be any of that particular species left.

Species become extinct or endangered for a number of reasons, but the primary cause is the destruction of habitat. Several groups of people, are concerned that certain animal species are threatened with extinction.

The Snow Leopard, is extinct as well as many other animals eg. California Condor, Tasmanian Wolf, Stellars Sea Cow.

Conservation, wise use of natural resources, such as soils, water, plants, animals, and minerals. We should recycle more, stop littering, stop using aerosol cans that are not environmentally friendly.

We should also try using more public transport to reduce car fumes.