Using a cognitive tool to support learning in interactive multimedia environments

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Using

A Cognitive Tool

to Support Learning in

Interactive Multimedia Environments

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ABSTRACT

For learners, the organizing and planning process for structuring information is sometimes more important than developing knowledge itself. This idea, although not new, is continually gaining popularity as one of the basic principles of a social constructivist paradigm.

This research reports on an investigation into how learners can use genre templates as cognitive tools for the writing process. These technology-based tools helped learners produce more organized and structured texts, especially when the information was represented in multiple modes (video, audio, text and data). This study was based upon the contention that technology-based templates can enhance learning outcomes, especially for learners with poor metacognitive strategies. Using the technology tools provided as support in a complex information landscape, learners were more able to synthesise the data into meaningful knowledge and concepts. If learners are aware of their metacognitive processes when using interactive multimedia products they further understand the relevance of developing and refining metacognitive skills and strategies for learning.
ACKNOWLEDGMENTS

This project could never have been completed without the help and support from many different people. Heartfelt thanks go to my supervisors Associate Professor Barry Harper and Professor John Hedberg who have throughout my candidature offered unconditional supervision, leadership and support in the development and refinement of the education process.

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We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time

(Little Gidding: Four Quartets, p.43).

If you think in seasons, plant cereals
If you think in decades, plant trees
If you think in centuries, educate your children
(Source Unknown).

I am also grateful to peers and colleagues at the University of Wollongong for their guidance in this study, thanks go to;

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Value others in order to value yourself

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To Tony Leeder-Smith for his devoted time and genuine concern in my health and well being. His words of wisdom throughout my candidature, continually became a source of inspiration,

Aim for the stars and you will land on the moon
You cannot improve if you remain in your comfort zone. If you remain in your comfort zone you will lose, this applies to anything in life that you do.

(Source Unknown).

Without his daily encouragement and objective viewpoint in maintaining a balance on life I would have been unhealthy, unfit and completely stressed at the end of this thesis. Finally thanks also to George Boulis for his unconditional love, support, patience, stamina and time spent editing and proof reading this research.
Declaration

This is to certify that the work presented in this thesis has not been submitted to any other University or Institution for the award of a degree.

Julie Gordon
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Interaction effects with GEFT and group

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Main effect with template
Main effect with LPQ
Interaction effects with LPQ and group
Main effect with GEFT
Interaction effects with GEFT and group

Information Sources

Main effect with template
Main effect with LPQ
Interaction effects with LPQ and group
Main effect with GEFT
Interaction effects with GEFT and group

Presentation

Main effect with template
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Interaction effects with LPQ and group
Main effect with GEFT
Interaction effects with GEFT and group

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Main effect with template
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Chapter One – Learning with Technology-based Cognitive Tools

This study adopted a constructivist perspective which asserts that we can only know about reality in a personal and subjective way (von Glaserfeld, 1989). Thus each person’s experiences dictate how (s)he interprets the world and the knowledge (s)he constructs from these experiences is based upon both the individual and social interaction (Cannon, 1995). A constructivist approach to learning is based upon the supposition that learning is “the product of self organisation” (von Glaserfeld, 1989, p. 136) which occurs as the learner interprets new experiences by relating them to past understandings. This process of learner self organisation may occur alone or in a social setting such as a classroom or in the home.

Constructivist learning theory recognises that each learner has a unique experience of the world and this influences how (s)he organises these experiences into knowledge structures and beliefs. Furthermore, these personal sets of knowledge structures and beliefs strongly influence the way in which (s)he interprets new learning experiences (Cannon, 1995; Jonassen, 1996). Learning experiences that are based upon constructivist theory acknowledge that learning is a purposive process and learners are ultimately responsible for the knowledge they construct (Driver et al., 1994). Since prior conceptions brought to learning situations influence what is learnt, the approach requires learners to be actively involved in the process of construction of meaning which often takes place throughout interpersonal negotiation.

Much of the evidence (Shank & Cleary, 1995; Harper et al., 1996; & Laurillard, 1993) about the lack of well designed interactive
multimedia software programs in large-scale schooling relates not only to economics, but also to teacher attitudes and beliefs about education and learning. It also relates to teachers' perceived workload and opportunities; that is, the type of individual learning support that cognitive scientists suggest can improve the learning process goes beyond the physical capability of most classroom teachers, at least for sustained periods of time.

The introduction of information and telecommunication technology, and specifically computers, into the educational process has been heralded as a panacea for education. The technology offers teachers the opportunity to individualise instruction, place children in open-ended student-centred investigations and to shift from their traditional instructor role to mentor and co-learner. The panacea however, like past revolutions in education, will go the way of previous technologies unless changes to our schools and the tools provided with computers occur, such as:

• a shift in teacher's pedagogical approaches;

• software that support the modes of instruction that cognitive scientists are telling us are appropriate (Harper et al., 1996, p. 12).

Bork (1995) argued these points strongly in his critical review of the failure of computers in schools and universities. He also supports the development of an extensive research base of empirical evidence to support claims for the efficacy of any changes that we instigate in learning environments.

This study seeks to present some of the evidence being called for and also to investigate a particular technique, that of using some specially constructed templates which supported student writing as they sought to respond to scientific problems. The use of the
templates was focussed upon the creation of specific writing genres and by reference to them, it was hoped that students would better express their arguments and solve the problems posed in logical ways. This notion has been supported by Jonassen (1996) who claimed that cognitive tools will have their greatest effectiveness when they are applied within a constructivist learning environment. However, simply providing learners with tools to plan and organise information is not enough; the learning environment in which the tools are used also has to be considered.

Other dimensions to this study were to provide an insight into what type of learning approaches students used in an interactive multimedia learning environment with the use or non-use of the genre templates. The outcomes from this study may stimulate instructional designers to develop more scaffolds or cognitive resources and support from a constructivist perspective and for researchers to investigate new research questions. Ultimately it should be the learner who benefits most from the outcomes of this study.

BACKGROUND TO THE STUDY

With the emergence of personal computers and various types of applications software in the 1980’s, the primary use of computers in the classroom has shifted from a content delivery device to a learning tool. Teachers and students started using word processing, desktop publishing, databases, spreadsheets, telecommunications, software, graphing and authoring programs. But they also began experimenting with a new generation of educational software packages that encouraged critical thinking, problem-solving, decision-making and exploration (Kearsley, Hunter & Furlong,
Today, well-designed interactive multimedia software packages are being developed for use in the education system. Learners now have the opportunity to use interactive multimedia software packages that contain a variety of learning tools. The use of these learning tools encourages students to become more active and familiar with their learning processes. Current well-designed interactive multimedia technologies can represent ideas in almost any mediated form and, provided one can generate a comprehensible metaphor for organising functional options and the underlying knowledge structures, the student can roam through the resources creating their own meanings and understandings of the phenomena they encounter.

Instructors have traditionally presented a linear narrative sequence, which unfolds the underlying structure of ideas. Aware that the sequence might at times be arbitrary and misleading, instructors have sought to find alternative ways to structure, represent and unfold relationships between ideas. With graphic and visual display coupled with large databases of resources, it is possible to explore an information space in whatever sequence appears appropriate to the task. When raising the idea Florin (1990, p. 30) saw information landscapes, "...as virtual towns, or intellectual amusement parks". However, within this context designers of multimedia learning environments have tended to be narrow in their view of how users will interact with the rich array of multimedia resources once a challenge, in the form of a problem to solve, has been posed. Instructional designers have not often taken full advantage of the technology that is being used to present these powerful ideas. Once the material has been presented to user(s) and they have interacted in the ways envisaged by the instructional designer (and often in new ways not considered by the
designer) the user is left to ponder and present her/his conclusions using more routine presentation technologies, such as pen and paper. Increasingly, users have access to multimedia technology but have lacked access to the rich digital media resources embedded in the learning environment. If students are to truly create their own meanings and understandings of the phenomena they encounter, designers need to incorporate user tools which will enable them to present their findings using the full array of resources contained in the packages.

Ferry (1997) suggested that there may be learners who are familiar with the subject matter presented, but find the organisation of information difficult to comprehend especially in an interactive learning environment as it is accessed on the choices of the learner. Several writers (Biggs & Moore, 1993; Blakley & Spence, 1990; Brown, 1978; Houssman, 1991; Jonassen, 1996) suggested that learners need to become aware of the processes of their learning as distinct from the content of learning to improve their learning outcomes. Salomon (1993) suggested that the learner should be responsible for recognising and judging patterns of information and then organising it, while the computer should perform calculations, store information, and retrieve it upon the learner’s command. Learners can become “aware of the processes of learning” by using interactive multimedia programs that are “designed to support the practiced aspect of learning” (Jonassen, 1996, p. 5). What has not been identified through research, is how students are coping with these educational tools for the organisation of information and knowledge for learning. Laurillard (1993), suggested that students would be better served if interactive multimedia programs provided support for student centred-learning but to date, many products still do not offer this support.
One form of support that could be provided to learners while problem-solving with interactive multimedia is the idea of a cognitive tool — a tool to support thinking, which can be used as needed by students in any given context. Thus the cognitive tool provides guidance or structure directly related to a problem or task. Jonassen (1992b) described cognitive tools as both mental and computation devices that support, guide and extend the thinking processes of users. Cognitive tools are thus “generalisable tools that can facilitate cognitive processing” (Jonassen, 1992b, p. 2) and which provide “just-in-time” support (Gerry, 1989). In effect they are “finger tip” tools (Perkins, 1993) that learners use naturally and effortlessly. This can help the learner displace some of the load of cognitive processing to a pad of paper, a calculator or even a piece of software (Reeves, 1996). Jonassen and Reeves (1996) recommended that “educators should empower learners with cognitive tools and assess their abilities in conjunction with the use of these tools” (p. 24). Jonassen (1997) also suggested that we should focus less on developing sophisticated multimedia delivery technologies and more on thinking technologies; those that engage thinking processes in the mind.

By its very nature, problem-solving is a student-centred, discovery-based strategy which challenges students to become active participants in the learning process. However, the extent to which this challenge is being taken up by students in the conventional classroom setting depends not only upon the enthusiasm of the classroom teacher for this student-centred approach but also the provision of well designed teaching resources that support this type of approach. This study examined the use of a set of cognitive tools of genre templates, and how they improved the students’ problem-solving.
Multimedia and information

When a learner is confronted with unfamiliar information that has been organised and presented from a variety of multimedia resources within an information landscape, they may find that metacognitive strategies used in the past do not help them to plan and complete a task. Reasons for this may relate to:

- learner prior knowledge: many researchers claim that learners need help to link new information with prior knowledge so that it becomes embedded into appropriate existing schema (Clarke, 1992; Gerry, 1989; Jonassen, 1998; Hannafin, 1989 and Kenny, 1993);

- preferred learning style and approach: researchers have suggested that learning styles and approaches influence the ways in which learners process information (Dunn, Cavanaugh, Eberle, & Zenhausern, 1982; Biggs, 1987; Claxton & Hurrell, 1987; Jonassen & Grabowski, 1993; Schmeck. 1988; Sims & Sims, 1995). Since most learners have preferred ways of learning, different cognitive styles and approaches require different modes of learning (Romiszowski, 1990; Tyler, 1993; Allison & Hammond; 1990 Stanton & Baber, 1992; Jonassen & Grabowski, 1993);

- the complexity of information presented to students. If the information presented is complex or in multiple representation forms, then the essential message can become lost and learners may have difficulty in dis-embedding the essential or main ideas, thus impairing the learners' ability to complete tasks (Chandler & Sweller, 1991; Sweller, 1994).

On the other hand learners may not have any problems in organising information that is presented to them in multiple representational modes while they complete a task in an information landscape. They may have appropriate metacognitive strategies and be able to critically review knowledge and information from multimedia resources. However, Jonassen (1992)
claimed that learners develop critical thinking skills as authors, designers, and constructors of knowledge; and learn more in the process than they do as the recipients of knowledge pre-packaged in educational communications. Therefore, if information is presented to learners in multiple modes, the use of interactive scaffolds could further help learners who have problems in organising information with the development of critical thinking skills. Students might identify a relationship between their approach to learning and the use of cognitive tools to support problem-based learning.

*Genre templates and cognitive tools*

Electronic genre writing templates are writing styles and scaffolds that support the development and manipulation of ideas for representation, they also have been identified as cognitive tools because they provide guidance and structure for learners in relation to a problem or task (Harper et al., 1996). There has been some controversy over whether or not cognitive tools can be described as planning and organisational tools that support teaching and learning (Roblyer, 1997). Jonassen (1997) referred to these as newer generations of idea processing tools, which integrate note taking, outlining and structuring compositions, and drafting and proofing the text all of which can also function as mindtools (Jonassen, 1997) for students' metacognitive processes. In this study, it is assumed that the genre templates provide a framework for organising student thoughts by assisting students in the modelling and scaffolding of information and knowledge.

In an interactive multimedia program with a variety of cognitive tools and resources to contend with, the templates may support
students by helping learners represent their knowledge (personal representations), building on what they already know and promoting the active and practiced aspects of the learning process. Templates may also support students' skills in the collection, analysis and manipulation of multiple media. This in turn allows learners to:

a) reflect on what they have learned and how they have come to know what they have learned and;

b) develop critical thinking skills as designers and authors of their own learning processes (Jonassen, 1996).

Schroeder and Kenny (1994) further supported this notion and suggest that by making such templates available and encouraging their use, educators are assisting students through a modelled form of outlining. Identifying concepts within their notes that bear some relationship to part of a template structure requires high-order thinking skill which,

a) focus students on important points;

b) help students gain familiarity with text structure;

c) aid retention;

d) generate useful alternative texts to supplement materials read; and

e) cause active participation in learning (Schroeder & Kenny, 1994, p. 966).

If learners have the opportunity within an interactive multimedia program to develop or use an existing genre-specific schema, this can have a number of generative and empowering consequences for their own learning processes and outcomes. The significance of this
is the development of the ability to communicate more effectively with a wider spectrum of the community by producing better responses to problems, especially when trying to provide a response from a variety of multimedia.

The experimental materials—Exploring the Nardoo

The increasing availability of CD-ROM-based interactive multimedia packages to support learning in classrooms offers teachers new pedagogical opportunities for student-centred and cooperative learning. However, the interactivity of many packages has been limited to "point and click" rather than employing instructional strategies that immerse and challenge students. The Interactive Multimedia Learning Laboratory at the University of Wollongong has developed an interactive multimedia package, Exploring the Nardoo, designed for schools, that not only attempts to develop problem-solving skills but also allows students to express their ideas with different forms of representation in their reports. This is of particular interest in relation to the need for the development of literacy across the curriculum. All curriculum designers need to be aware of the role writing in its many forms plays in the development of literacy, the cognitive support for all learning styles it provides and consequently seek to develop the strategies which can support this.

One approach to the improvement of literacy as suggested by the NSW Department of School Education Literacy and Learning Project Metropolitan East (1993), is the across curriculum teaching to students of particular writing styles or genres, which will provide students with a guide to presenting their ideas in all discourse communities. The student support for note taking and the
organisation of information and knowledge with the resulting “solutions to problems” needs to include modelling of the various discourses used in different communities. Different genre templates have been included to support students’ learning and metacognitive processes.

In the current study the software package *Exploring the Nardoo*, which contains electronic genre templates, was used to investigate how students are coping with new technology-based cognitive tools in an interactive multimedia problem solving program. The software package (Harper et al., 1996) included the genres of Report, Explanation, Procedure, Exposition, Discussion, Narrative, Recount, and Review. The genre template may also provide a means of composing meaning for both the writer and the reader/listener, while at the same time providing a means of reflection, re-ordering and creating new learning links between new and prior knowledge. The production of an effective piece of writing or presentation in any media may provide the student with a means of consolidating these links. It can also enhance the student’s confidence, self-esteem and motivation to stay on and complete a task (Harper et al., 1996). The availability of a range of genre templates with added character-guide or text-based support embodies the notion of providing, “strategies that help them encode the information they encounter (Schroeder & Kenny 1994, p. 963).” The genre templates are contained within an information landscape and are generally available for students to use as they gather and process information when synthesising a written response to a given task from within the software package.

*Exploring the Nardoo* provides the student with a flexible set of tools made available through the metaphor of a personal digital
assistant to assist in the investigation process. This package also provides the ability to record thoughts and impressions in a digital notebook. It holds the potential for students to reorganise or revise their thoughts to better make sense of what they see and hear. Students are able to document their emerging ideas in support of an investigation or problem-solving exercise whilst viewing different media. This package supports the formulation of new schemata by the learners in the process of accommodating the new information. It incorporates problems that challenge students to become active participants in the learning process. By providing a metaphor related to the real world, students are encouraged to apply scientific concepts and techniques in new and relevant situations in this ecology-based application, throughout the problem-solving process. In so doing, the learner is likely to become more interested in developing questions, ideas and hypotheses about the learning experiences encountered. As an alternative teaching/learning strategy in the development of inquiry and problem-solving techniques this package incorporates high quality visual materials in the form of graphics, sound, text and motion video together with scientific measuring tools to aid in the construction of understanding.

Simulations and support tools that allow multimedia reporting are embedded in the package and are reinforced by several cognitive tools for the writing process. These tools not only include details about genre but also scaffolding templates to help the learner (Harper et al., 1996). An example of a genre template within this package is found in Figure 1.1 with the digital notebook.
For many students the actual collection of materials before writing is a difficult process in itself. Students with poor reading and research skills can be disadvantaged in this process. In addition, the careful and guided use of such supportive structures as the genre templates has been incorporated in Exploring the Nardoo to provide invaluable support for these students by reducing the amount of reading, lowering the cognitive load, in relation to student-centred learning. Genre as instruments of ... communication ... can have generative power (Swales, 1990, p. 122). If different genres are available to students during the writing process in the form of electronic templates in the context that they are investigating,
students may be provided with even greater power and more sophisticated tools of communication. Furthermore, genre templates may not only support learners during the writing process, they may provide support for students' metacognitive process. Genre templates can provide the means for mapping and exploring new territories, but the empowerment comes with practice, reflection, cognitive and teacher support. This empowerment is characteristic of the values and principles implemented in the learning environment *Exploring the Nardoo*, from the theoretical perspective of a constructivist philosophy.

*Research questions*

This study sought to explore the ways in which students employed aids to support their problem-solving. The questions posed as part of the exploration were:

1. Do the genre templates assist as a cognitive tool to help students make sense out of diverse information?

2. How does the genre template help the student organise information?

3. How do students use the cognitive support templates? What learning approach do students use?

It was assumed that the genre templates would assist the students' writing processes and would function as cognitive tools in that they would reduce the need to structure information being collected. The assessment of the integration of information would be through the learner hypotheses generated or the divergent individual ideas collected.
4. Is there a relationship between student approaches to learning and the use of cognitive tools in problem-based learning?

This is a more general issue. Students were interviewed to determine how they used the templates and what they felt the templates provided to assist in idea organisation.

5. What other tools support the organising of information that is presented in multiple modalities for representation?

This question was aimed at further tool development. For instance, some students might find an idea-organisation tool more useful than others. Additional ideas for other tools would be useful in the addition of support for different types of learning tasks.

OVERVIEW OF THE METHODOLOGY USED IN THIS STUDY

Several inquiry techniques were employed during this study that required a mixture of context-specific methods to meet the unique requirements of the specific research questions. Multiple data gathering techniques were needed to ensure that the data were comprehensive, reliable and valid. Data were gathered from: post treatment student questionnaire, student investigation results (learning outcomes), a learning process questionnaire (LPQ), a cognitive style inventory (Group embedded figures test-GEFT), interviews, observations and tracking data (monitoring of students process notes) were collected.
Variables and measures

Several variables for the design of this study were selected and identified. The independent treatment variable consisted of two conditions (1) student access to the genre template and (2) no access to genre template. The genre template consisted of electronic-based text scaffolds that could be imported into a text tablet for the purpose of facilitating the organisation of information for representation from a variety of multimedia sources in a constructivist learning environment.

The multiple dependent variables were the outputs in the form of learning outcomes — the student investigation results from a given task with the use/non-use of the treatment. Assessment of the student learning outcomes was based upon a criterion developed together by the researcher, teachers and students. The criteria were then given to the students at the beginning of the task with numerical values to be placed on the student learning outcomes and subsections. The dependent measures consisted of the following learning outcome measures: (total scores), style and structure, the gathering of embedded information sources, presentation and quality of argument. The subsections were chosen so as to further identify comparisons and interactions within the total score that relate to student access and use/non-use of the treatment.

In order to account for two important and different considerations, indications of the learner's style as well as their approach to learning, using some standard measures, were also collected. Learning styles and learning approaches represent two different perspectives on student learning processes, each of which appear to influence achievement (Cameron & Treagust, 1997). In addition,
both are conceptualisation's that provide a framework for understanding how students might learn and interact with the genre templates and their learning environment. These perspectives on student learning processes were investigated to identify how they influenced students' use or non-use of the genre templates and if so what the nature of the influence was. One way of identifying this issue was to consider why there are differences between students' learning, in terms of approaches to learning and cognitive style. The instruments that were used to measure this were the LPQ (Learning Process Questionnaire) and GEFT (Group Embedded Figures Test). This is briefly discussed below and a further description is found in chapter three.

The learning outcome measure total score consisted of the other sub sections of style and structure, information sources, presentation and quality of argument. Style and structure referred to whether or not students had chosen the appropriate style or genre and if it was used. Students needed to have demonstrated whether or not they provided evidence of the appropriate structure recommended by the embedded genre together with appropriate use of language. Information sources represented information chosen by students from a range of sources. These sources had to consist of the most appropriate pieces of information and used as evidence in support of her/his argument. Content experts had preselected primary data, secondary data and a combination of the two as examples of evidence to be used from information sources, the data were contained in the marking criteria for markers. If students produced combinations of evidence that the content experts had not found or mentioned then these were considered at length by the markers. This section was also marked out of five. Presentation addressed how students' presented the task, the outcome of the task required
students to present the information as an article for a newspaper and presentation was marked out of two. The quality of argument section presented by students was marked out of eight. Students needed to demonstrate that they could produce an appropriate quality of argument, i.e. the solution “complete” and whether it provided a clear and accurate explanation of possible solution(s) to the problem. This answer should also have included appropriate references to supporting media, identified relevant information and clearly communicated/presented the evidence to support their argument in a logical and coherent manner. If students did not respond to this section they received a level one response and no marks. The sub sections of style and structure, information sources, presentation and quality of argument were added together and students were given a numerical mark on their total score in recognition of a learning outcome. This is discussed further in chapter three and four.

Prior to the collection of the data, content experts and teachers had identified the achievement outcomes. After the collection of the dependent data content experts and teachers marked the learning outcomes so as not to bias the protocol. The assessment criterion used to mark the learning outcomes was the same criterion used by students to complete the task; for example, the learning outcomes, total scores, style and structure, information sources, presentation and quality of argument were given to students at the same time as the task. The reason it was done this way was so that students could develop a clearer understanding of the assessment criteria, and so that students’ knew before undertaking the task what was expected and required from them. The assessment criteria given to students at the beginning of the task and used to mark by teachers
and content experts included the learning outcomes and the subsections. The hypotheses were derived from the assessments.

**Template use**

*Learning outcomes*

This was measured by summing the results of all the subscales below. The subscales were standardised using a z score technique before being combined into a composite score of learning.

**H1:** Students who use the genre templates will score higher on learning outcome measures than students who do not.

*Style*

This was defined as the appropriate structure chosen (Discussion genre) consisting of an introduction, three arguments for and three arguments against using appropriate language with a conclusion to report on the problem-solving task and was scored as five. High scores represented (5) in that all sections were presented with an appropriate format in logical and coherent manner. Low scores represented (1) in that there was no defined structure as per the genre with parts missing. The scale was (1) through to (5) with (5) being the highest score gained for this section.

**H2:** Students who use the genre templates will use a more appropriate style than students who do not.

*Use of information*

This was defined as the most appropriate choice of evidence, using concrete supporting details (primary data) selected from a range of embedded resources, to support the argument presented and was
scored as five. High scores represented the demonstration of strong evidence acknowledging credible resources (measurements before and after the dam with one graphic and no videos). Low scores represented weak, inappropriate or non-use of credible resources as evidence and was scored as (1). The scale was (1) through to (5) with (5) being the highest score gained for this section.

**H3:** Students who use the genre templates will choose more appropriate information from a range of resources than students who do not.

*Presentation*

This was defined as the aesthetic format of the final product which was to be presented as a newspaper article and was scored out of (2). High scores represented an essay or newspaper article format including text and a graphic and was scored as two. Low scores (1) represented no resources or use of irrelevant resources. The scale was (1) through (2) with (2) being the highest score gained for this section.

**H4:** Students who use the genre templates will present their investigation results more appropriately than students who do not.

*Quality of arguments*

This was defined as an accurate explanation of possible solutions to the problem and was scored as (8). High scores represented the demonstration of appropriate references to supporting media, identifying relevant information and clearly communicating, presenting the evidence to support their arguments in a logical and coherent manner. Low scores represented a non-response or invalid argument based on unsupporting details and inappropriate
references, with little attempt at the construction of a possible solution to the argument. The scale was (1) through to (8) with eight being the highest score gained for this section.

H5:1 Students who use the genre templates will employ a higher quality of arguments than students who do not.

**Approaches to learning and cognition**

The researcher aimed to determine if student results could be predicted by learning approaches and measured them by using the LPQ and GEFT. Thus the learning approach was a modifying variable. The hypotheses for the outcome measures based on the learning style modifying variables have been placed in similar groups. They include: learning outcome measures (total scores), style and structure, the gathering of embedded information sources, presentation and quality of argument. The independent learning approach measures consisted of profiles from two categories of the LPQ, (Deep and Achieving, Surface and Low Achieving) and two categories from the GEFT (Field dependent and Field independent).

The following hypotheses focus on predicting certain directions. Deep and surface approaches are mutually exclusive (Biggs & Moore, 1993, p. 92). It is predicted that the students’ applying a surface processing approach would achieve a higher argument on outcomes with access to the genre template.
Learning outcomes

LPQ

H1.2 Students who are Deep and Achieving learners with access to the genre template will score higher on learning outcome measures than students who are Surface and Low Achieving learners.

H1.3 Deep and Achieving students with access to the genre template will score higher on learning outcome measures than Deep and Achieving students without access to the template.

H1.4 Deep and Achieving students with access to the genre template will score higher on learning outcome measures than Surface and Low Achieving students without access to the template.

H1.5 Surface and Low Achieving students with access to the genre template will score higher on learning outcome measures than Surface and Low Achieving students without access to the template.

H1.6 Surface and Low Achieving students with access to the genre template will score higher on learning outcome measures than Deep and Achieving students without access to the template.

H1.7 Surface and Low Achieving students without access to the genre template will score higher on learning outcome measures than Deep and Achieving students without access to the template.

H1.8 Surface and Low Achieving students with access to the genre template will score higher on learning outcome measures than Deep and Achieving students with access to the template.
H1:9 Students who use the genre templates will score higher on learning outcome measures than students who do not.

H1:10 Students who are Field Dependent learners with access to the genre template will score higher on learning outcome measures than students who are Field Independent learners.

H1:12 Field Dependent students with access to the genre template will score higher on learning outcome measures than Field Dependent students without access to the template.

H1:13 Field Dependent students with access to the genre template will score higher on learning outcome measures than Field Independent students without access to the template.

H1:14 Field Independent students with access to the genre template will score higher on learning outcome measures than Field Dependent students without access to the template.

Style and structure

LPQ

H2:2 Students who are Deep and Achieving learners with access to the genre template will score higher on style and structure than students who are Surface and Low Achieving learners.

H2.3 Deep and Achieving students with access to the genre template will score higher on style and structure than Deep and Achieving students without access to the template.
H2.4 Deep and Achieving students with access to the genre template will score higher on style and structure than Surface and Low Achieving students without access to the template.

H2.5 Surface and Low Achieving students with access to the genre template will score higher style and structure than Surface and Low Achieving students without access to the template.

H2.6 Surface and Low Achieving students with access to the genre template will score higher on style and structure than Deep and Achieving students without access to the template.

H2.7 Surface and Low Achieving students without access to the genre template will score higher on style and structure than Deep and Achieving students without access to the template.

H2.8 Surface and Low Achieving students with access to the genre template will score higher on style and structure than Deep and Achieving students with access to the template.

GEFT

H2:9 Students who use the genre templates will score higher on style and structure than students who do not.

H2:10 Students who are Field Dependent learners with access to the genre template will score higher on style and structure than students who are Field Independent learners.

H2:11 Field Dependent students with access to the genre template will score higher on style and structure than Field Dependent students without access to the template.
H2:12 Field Dependent students with access to the genre template will score higher style and structure than Field Independent students without access to the template.

H2:13 Field Independent students with access to the genre template will score higher on style and structure than Field Dependent students without access to the template.

H2:14 Field Independent students with access to the genre template will score higher on style and structure Field Independent students without access to the template.

*Information sources*

*LPQ*

H3:2 Students who are Deep and Achieving learners with access to the genre template will score higher on information sources than students who are Surface and Low Achieving.

H3.3 Deep and Achieving students with access to the genre template will score higher on information sources than Deep and Achieving students without access to the template.

H3.4 Deep and Achieving students with access to the genre template will score higher on information sources than Surface and Low Achieving students without access to the template.

H3.5 Surface and Low Achieving students with access to the genre template will score higher on information sources than Surface and Low Achieving students without access to the template.
H3.6 Surface and Low Achieving students with access to the genre template will score higher on information sources than Deep and Achieving students without access to the template.

H3.7 Surface and Low Achieving students without access to the genre template will score higher on information sources than Deep and Achieving students without access to the template.

H3.8 Surface and Low Achieving students with access to the genre template will score higher on information sources than Deep and Achieving students with access to the template.

**GEFT**

H3.9 Students who use the genre templates will score higher on information sources than students who do not.

H3.10 Students who are Field Dependent learners with access to the genre template will score higher information sources than students who are Field Independent learners.

H3.11 Field Dependent students with access to the genre template will score higher on information sources than Field Dependent students without access to the template.

H3.12 Field Dependent students with access to the genre template will score higher on information sources than Field Independent students without access to the template.

H3.13 Field Independent students with access to the genre template will score higher on information sources than Field Dependent students without access to the template.
H3:14 Field Independent students with access to the genre template will score higher on information sources Field Independent students without access to the template.

**Presentation**

**LPQ**

H4:2 Students who are Deep and Achieving learners with access to the genre template will score higher on presentation than students who are Surface and Low Achieving learners.

H4.3 Deep and Achieving students with access to the genre template will score higher on presentation than Deep and Achieving students without access to the template.

H4.4 Deep and Achieving students with access to the genre template will score higher on presentation than Surface and Low Achieving students without access to the template.

H4.5 Surface and Low Achieving students with access to the genre template will score higher presentation than Surface and Low Achieving students without access to the template.

H4.6 Surface and Low Achieving students with access to the genre template will score higher on presentation than Deep and Achieving students without access to the template.

H4.7 Surface and Low Achieving students without access to the genre template will score higher on presentation than Deep and Achieving students without access to the template.
H4.8 Surface and Low Achieving students with access to the genre template will score higher on presentation than Deep and Achieving students with access to the template.

GEFT

H4:9 Students who use the genre templates will score higher on presentation than students who do not.

H4:10 Students who are Field Dependent learners with access to the genre template will score higher on presentation than students who are Field Independent learners.

H4:11 Field Dependent students with access to the genre template will score higher on presentation than Field Dependent students without access to the template.

H4:12 Field Dependent students with access to the genre template will score higher on presentation than Field Independent students without access to the template.

H4:13 Field Independent students with access to the genre template will score higher on presentation than Field Dependent students without access to the template.

H4:14 Field Independent students with access to the genre template will score higher on presentation Field Independent students without access to the template.
Quality of Argument

LPQ

H5.2 Students who are Deep and Achieving learners with access to the genre template will score higher on quality of argument than students who are Surface and Low Achieving learners.

H5.3 Deep and Achieving students with access to the genre template will score higher on quality of argument than Deep and Achieving students without access to the template.

H5.4 Deep and Achieving students with access to the genre template will score higher on quality of argument than Surface and Low Achieving students without access to the template.

H5.5 Surface and Low Achieving students with access to the genre template will score higher on quality of argument than Surface and Low Achieving students without access to the template.

H5.6 Surface and Low Achieving students with access to the genre template will score higher on quality of argument than Deep and Achieving students without access to the template.

H5.7 Surface and Low Achieving students without access to the genre template will score higher on quality of argument than Deep and Achieving students without access to the template.

H5.8 Surface and Low Achieving students with access to the genre template will score higher on quality of argument than Deep and Achieving students with access to the template.
GEFT

H5:9 Students who use the genre templates will score higher on quality of argument than students who do not.

H5:10 Students who are Field Dependent learners with access to the genre template will score higher on quality of argument than students who are Field Independent learners.

H5:11 Field Dependent students with access to the genre template will score higher on quality of argument than Field Dependent students without access to the template.

H5:12 Field Dependent students with access to the genre template will score higher on quality of argument than Field Independent students without access to the template.

H5:13 Field Independent students with access to the genre template will score higher on quality of argument than Field Dependent students without access to the template.

H5:14 Field Independent students with access to the genre template will score higher on quality of argument Field Independent students without access to the template.

Definitions of terms and operational definitions

Cognitive tools

Cognitive tools refers to technologies, tangible or intangible that enhance the cognitive powers of human beings during thinking, problem solving and learning (Jonassen, 1996).
Constructivism

Constructivists maintain that we construct our own reality through interpreting our experiences in the world. From the constructivist perspective, the ultimate nature of reality or whether it even exists does not matter as much as our unique and shared constructions of reality (Jonassen, 1996).

Genre templates

Are writing styles and scaffolds that support the development and manipulation of ideas for representation (Harper, Hedberg, Brickell, Wright & Corderoy, 1995).

Learning process

Refers to students' motives and strategies for learning (Biggs, 1987a, p.10).

Metacognition

Knowledge concerning one's own cognitive processes and products (Biggs, 1997, p. 10).

Multimedia

Multimedia refers to the integration of media such as text, sound, graphics, animation, video imaging and spatial modelling into a computer system (Von Wodike, 1993).

Problem solving

One's effort to achieve a goal for which one does not have an automatic solution (Shunk, 1991a).
Scaffolding

Scaffolds are temporary frameworks to support any kind of learning (Jonassen, 1996).

SIGNIFICANCE OF THE STUDY

Firstly, the findings of this study should add to understanding of learner use of specific genre templates to scaffold problem solving outcomes when they have been incorporated into an information landscape within an interactive multimedia software package. The identification of how students use the genre templates, together with the strategies they employ, should guide future refinements of these tools.

Genre templates have the potential to play a small and significant role for students with poor metacognitive strategies in the reduction of cognitive load associated with synthesising a written response to a problem-solving task. If the use of the genre templates creates too much cognitive load on the learner then its use may be counter productive. The methods employed and the findings from this research should provide some assistance to instructional designers, other educational practitioners and researchers as they develop and evaluate further cognitive resources in similar contexts.

Secondly, this study has worked with a particular type of cognitive tool in a problem-solving context. The results may stimulate development of other cognitive tools to follow a similar research path and to build upon the findings of this study. Instructional designers, other educational practitioners, and researchers may
wish to improve on the genre templates or modify them to apply to other contexts.

Thirdly, the findings should add to our understanding of how learners interact and use the static tools (genre templates) and what metacognitive strategies they employ to synthesise a written response.

Limitations

A study of this scope cannot develop comprehensive answers to the important questions asked, but it can give some clues as to the ways in which different learners interact with these types of learning materials and tools. The following are limitations of the study: students were randomly selected from a selective high school; this study will only be generalised to that school. One way of minimising limitations was to, during the research process, go back to the participants to verify the accuracy of interpreted meanings. An “audit trail” documenting the procedures was used to enable others to assess or replicate the study. Methodological field notes, transcripts of student and teacher interviews and observations were kept, reflecting on possible biases and means for dealing with them throughout the study.

Delimitations

The study did not extend beyond the genre templates and no other generic tools were employed in the problem-solving process. The study also did not attempt to interview all students; rather the focus was on overall effects and the use of the particular package in achieving its results.
The following chapters synthesise a theoretical focus based on how students used cognitive tools within an interactive multimedia environment. The research design was based upon an interpretivist approach. A research agenda with an interpretivist goal is focused on portraying "how" education works by describing and interpreting phenomena related to human communication, learning, performance and the use of technology. The reason this approach has been taken is so that the researcher would arrive at a deeper understanding of what it means to be learning within the context of this type of program.

Chapter Two outlines the outcomes of the study that support the theoretical perspectives of constructivism, situated cognition, metacognition and learning. Previous research studies about these issues and cognitive tools that were relevant to the context of this study are also outlined and provide a source of research techniques.

Chapter Three summarises the research design, mode of inquiry, sample, site, methods used for data collection procedures and analyses. The relationship between how the quantitative and qualitative data supported the research hypotheses and questions is also discussed. The treatment for this study was a task derived from within the software package used in the study. Chapter Three also includes the criterion that was used for the investigation result (learning outcomes), other variables and the dependent and independent measures. These consisted of the Group Embedded Figures Test (GEFT) results which classify students as field independent or field dependent, and the Learning Process Questionnaire results developed by Biggs, (1987a) which identifies students' approaches to learning. Additionally a Post Treatment
Questionnaire on learning processes developed by the researcher was administered.

Chapter Four analyses the data. The hypotheses are stated and the qualitative and quantitative data that support them is given as provided evidence to the study. A summary of the data analysis, and research questions from this study is presented.

Chapter Five concludes with findings and future directions for investigation. Limitations of the current study are discussed and avenues for further research are identified.

The appendix provides an example of instruction on the use of the software package used in this study.
Chapter Two - Review of Literature

Introduction

The previous chapter explained that the current study sought to investigate how metacognition, together with the use of genre templates that support the writing process, can be facilitated in an interactive multimedia learning environment. The purpose of this review of relevant research is to provide theoretical guidance for the implementation and use of the genre templates as cognitive support while problem solving.

The supportive theory for this research is based upon a constructivist epistemology. Although constructivism is not a new philosophy of learning, there are now efforts to understand the application of constructivist principles across all areas of education (Tobin, Tippins & Gallard, 1994). This review develops an understanding of how this approach can be applied to help learners use the genre templates and metacognitive strategies during the learning process.

In the current study, cognitive support is presented to learners as scaffolding genre templates in an interactive multimedia learning environment. To understand meaningful learning within these contexts, the researcher needed to examine how learners used cognitive support. Students may need to use cognitive support in the organisation of collected information and the presentation of reconstructed knowledge from multimedia resources when formulating a solution to a problem. Different presentation genre have been used to investigate this issue (Harper et al., 1996).
Research into the development and design of models that support students' learning processes may help to identify how learners use cognitive support tools, with new technologies in problem solving learning environments that engage higher order thinking skills.

To date, the majority of research evidence is based on anecdotal reports and case studies. The current study aimed to contribute to overcoming the paucity of literature in this area by investigating how students are coping with new tools and providing information about student use of cognitive tools - genre templates. This will assist educators in the development of key components of the learning processes using educational software products. The key areas of this literature review are: firstly, the key concepts supported by theoretical approaches to learning, (constructivism, situated cognition, metacognition, learning styles/approaches, assessment and cognitive tools in relation to the learning environment); Secondly, the review will identify the key issues underlining the current study.

A REVIEW OF THE RESEARCH CONTEXT IN THE LITERATURE

Educators have long debated the most appropriate instructional role for technology, particularly computer technology. Prior to the 1980's, the issues of this debate are summarised by Roblyer (1996). He states that the:

... major disagreement divided people into three groups: those who advocated using computers primarily as tools (for example, for word processing and numerical calculations), those who viewed them mainly as teaching aids or "tutors" (for example, using drills, tutorials and simulations), and those who believed the most powerful use was programming (the "tutee" use). But these groups would have generally agreed that each of these approaches had its
Jonassen and Reeves (1996) claimed that it is important to distinguish the "cognitive tools" perspective from the traditional educational media approach. It is also important to highlight differences between this conception of technology and earlier perspectives of using computers to support learning that have not been successful. Ever since Taylor (1980) presented his classic model of the roles of computers in education as "tutor", "tool", and "tutee," many educators and commercial entrepreneurs have predicted that computers would revolutionise education through one or more of these roles. In reality, none of these approaches lived up to its promise (Jonassen, 1996).

In recent years, advocates of computer-based instruction and intelligent tutoring systems (ITS) who represent the computer as "tutor" have begun to acknowledge the lack of impact they have had on mainstream education and training (Lajoie & Derry, 1993). At least part of this failure stems from the overly restrictive perspective of students as perceivers or recipients of educational communications that characterises the research in this field. Another factor contributing to the lack of success of ITS is that the technical difficulties inherent in building student models and facilitating human-like communications have been greatly underestimated by proponents of the "tutor" model.

The computer as "tool" approach has also disappointed many of its proponents, although there have been some successes when tools have been embedded within innovative pedagogy such as a whole language approach to literacy development (Bruce & Rubin, 1993). In many cases, software tools such as word-processing, spreadsheet,
database, and computer-aided design (CAD) programs have failed to improve teaching and learning significantly because they have been largely relegated to the service of a traditional "instructivist" pedagogy.

The results of the "tutee" role for computers in education, despite the almost religious fervour with which it has been embraced in some circles (Papert, 1980), have also been much less spectacular than promised. According to the computer as "tutee" approach, students develop higher-order thinking skills and creativity by teaching the computer to perform tasks, e.g., draw a picture, through the use of "friendly" programming languages such as Logo (Papert, 1980) and microworlds such as Karel the Robot (Popyack, 1989). Studies aimed at investigating the effects of Logo (Pea & Kurland, 1987) have failed to demonstrate the cognitive advantages promised by Papert and others. Defenders of the "tutee" approach would maintain that the implementations of Logo investigated in most studies were too brief and unfocused. To be sure, many applications of Logo and other microworlds described later in the literature seem to lack the "mindful engagement" that Salomon and Globerson (1987) argue is necessary for learning. More intensive applications of Logo wherein students are engaged in meaningful tasks over longer periods of time have demonstrated more impressive cognitive effects (Harel, 1991; Papert, 1993). Now educators must continually review the goals of education and the growing information base on classroom strategies, with respect to the changes brought about by the use of educational technology.
Changes brought about by technology

Subsequent years have witnessed two trends with unprecedented effects on the course of educational technology: firstly an increase in the number and types of technology resources available and secondly, dramatic shift in beliefs about the fundamental goals and strategies of education itself. These two trends have not developed in isolation; their roots are intertwined in the larger social and economic conditions that define and shape our modern world. In the past, educational goals reflected society’s emphasis on ‘the need for basic skills’ i.e. reading, writing, and arithmetic and a certain body of information that was considered essential for all citizens. Students were considered educated if they could demonstrate the abilities to read at a certain comprehension level; apply grammar, usage and punctuation rules in written compositions; solve arithmetic problems that required addition, subtraction, multiplication and division; and state certain series of facts such as, events leading up to the Civil War. Roblyer (1996) claims that,

Many educators have come to believe that the world is changing too quickly to confine educational goals to specific information or skills; they believe that education should emphasise more general capabilities for learning to learn that will help future citizens to cope with inevitable changes. For example, instead of learning specific items of information, they want to emphasise training in ways of acquiring, sorting through and using information. Knowing what question to ask will be as important as, or more important than giving the right answers (p. 55).

The current educational goals and methods are expressed by two points of view. As goals of education began to change to reflect new social and educational needs, teaching strategies also changed, and so, consequently, have strategies for integrating technology into
teaching and learning. Today, the educators’ definitions of the appropriate role of technology depend on their perceptions of the goals of education itself and appropriate instructional methods to help students attain those goals. Many educators such as Brown (1996), Dunlap and Grabinger (1996), Fosnot (1996), Hedberg and Harper (1997), Jonassen (1992a, 1996 & 1997), Lebow (1993), Robyler (1996), Shank and Cleary (1997) and Wilson (1995) agree that changes are needed in education. However, identifying exactly how new skills and methods will differ has become increasingly controversial. Shank and Cleary (1997), argue that schools should teach almost none of the skills traditionally considered important. Others feel that many of these skills are still necessary but that schools should implement different kinds of instructional models to help foster them (Jonassen 1997 & Hedberg and Harper 1997).

Disagreement among learning theorists such as Fosnot, 1996; Hedberg & Harper, 1997; Jonassen, 1992a, 1996 & 1997; Lebow, 1993; Robyler, 1996; Shank & Clearly, 1997 and Hannafin et al., (1994) continue today and centre on which strategies will prove most effective in achieving today’s educational goals. Roblyer (1996) indicated,

...that controversy has served as a catalyst for an evaluation of two very different views on teaching and learning. One view, called directed instruction, is grounded in behaviourist learning theory and the information processing branch of the cognitive learning theories. Another view, referred to as constructivist, evolved from other branches of thinking in cognitive learning theory. Several software applications, for example drill and practice and tutorials, are associated more with directed instruction; the majority of software applications such as multimedia applications and telecommunications can enhance either directed instruction or constructivist environments, depending on how teachers integrate them into classroom instruction (p. 58).
People with radically different views on an issue frequently use different terms to describe essentially the same things. These differences in language signal some fundamental differences between the two models. It is important to recognise that both directed instruction and constructivist approaches attempt to identify what Gagne (1995) would call the “conditions of learning” or the “sets of circumstances that occur when learning occurs” (p. 2). Both are related to the work of respected learning theorists and psychologists who have studied both the behaviour of human beings as learning organisms and the behaviour of students in schools and classrooms. However, the two approaches diverge when they define learning and describe the conditions required to make learning happen and the kinds of problems that interfere most with learning. Learning theorists disagree because they attend to different philosophies and learning theories: they take different perspectives on improving current educational practice. Yet Brown (1996), suggested that both kinds of strategies may prove useful to teachers in addressing commonly recognised instructional and educational problems.

Differences in philosophical foundations begin with underlying epistemologies (beliefs about the origins, nature and limits of human knowledge). Constructivists and their opposites (called objectivism or instructivist) come from separate and very different epistemological “planets”, although both planets nurture many different tribes or cultures (Molenda, 1991; Philips, 1995). On the objectivist side, philosophers believe that knowledge has separate real existence of its own outside the human mind; advocates of directed instruction believe that learning happens when this knowledge is transmitted to the learner. On the constructivist side, philosophers believe that humans construct all knowledge in their
minds, so that learning happens when a learner constructs both mechanisms for learning and his or her own unique version of the knowledge, coloured by background, experiences and aptitudes (Wills, 1995).

Relevant theoretical models of learning and technology

The limitations of behavioural theory made researchers look more closely at other theoretical models of learning. Thus cognitive theoretical models such as those of Piaget (1971) and Bruner (1996) received more attention. Bruner's theory of instruction, as presented in "Towards a Theory of Instruction" (1996), is an example of cognitive theory application in this area. He claimed that a theory of instruction should take into account: the nature of persons as knowers; the nature of knowledge; and the nature of the knowledge-getting process.

Past studies that focused upon behavioural models of learning were usually quantitative and based upon some form of comparison between experimental and control groups. The findings from such studies have limited application because of the reasoning that some successful applications were associated with drill and practice software. Whilst many of these earlier attempts were criticised as boring and lacking in strategy to motivate students (Sewell, 1990), others could be effective in narrow applications such as drill and practice associated with the learning of multiplication tables or spelling rules (Price, 1991). Drill and practice software can be considered as a legitimate application of education theory to the design of computer-based instructional systems, however, the context is limited to specific situations where learning outcomes are observable and measurable.
Moreover, research associated with cognitive learning theory is usually qualitative because it lends itself to a holistic approach that views learning from multiple perspectives, and reflects the complexity of the interactions between those involved in the learning process. Whilst the problem of generalisable findings exists, there is value in qualitative studies that focus upon subjects in natural settings. For the current study the research design was administered and data collected in the natural setting of a classroom. This involved students working in their own computer laboratories at their favourite computer stations.

Jean Piaget

Piaget studied the nature of children at different ages and focused upon the innate developmental stages of children as they relate to their acquisition of knowledge. It has been argued that the contribution of Jean Piaget to the understanding of learning was more in developmental psychology than in learning theory (Bigge & Shermis, 1992). For Piaget the mental development of any child consisted of progress through a succession of stages or periods. Each stage extends the preceding stage, reconstructs cognition on a new level and comes to surpass the earlier stage.

However, Piaget was criticised by some researchers as they claimed that his theory limited his interpretation of his interview data (Novak, 1977a; Donaldson, 1978; Modgil & Modgil, 199: MacNamara, 1982). They also have claimed that he failed to recognise adequately the powerful roles that language development plays in the development in the pattern of children's reasoning. This is an important criticism as many researchers have shown that language plays an important role in the development of concepts (Garton,

Seymour Papert

Papert believed “that certain uses of very powerful computational technology and computational ideas can provide children with new possibilities for learning” (Papert, 1980, p. 17) and asserted that computers “should serve children as instruments to work and to think with, as the means to carry out projects, the sources of concepts to think about new ideas”. (Papert, 1993, p. 168). He admitted that he was strongly influenced by Piaget’s notion that to understand is to invent in a new domain (Papert, 1993, p. 169). In this way knowledge becomes useful and can be shared with others.

Papert argued that the notion of “different ways of knowing” was the most important contribution of Piaget. Furthermore, these “different ways of knowing” are used by learners to solve real world problems every day. He prefers to use the term “constructionism” (Papert, 1993, p. 142) to describe the intellectual processes involved in the reconstruction of knowledge for specific purposes. Often this knowledge is not learned at school and does not conform to the traditional school-based notion of what proper knowing is. The learner uses an idiosyncratic set of cognitive tools in this reconstruction process. While Papert’s ideas appear to be part of a ‘constructivist’ approach to learning, he claims that his term is a “personal reconstruction of constructivisim” (p. 142) and is different. Papert asserts that constructivism expresses the theory
that knowledge is built by the learner and not supplied by the teacher.

**Ausubel**

Ausubel argued that the provision of cognitive scaffolding supports learners when they acquire new information and the idea of an advanced organiser developed from his research (Ausubel, 1960; Ausubel & Youseff, 1963; Ausubel, 1968). Various claims have been made about the effectiveness of advanced organisers (Clarke, 1991; Mayer, 1980; Mayer, 1975; Merrill & Stolurow, 1966), and several reviews of research findings reported small improvements in learning across all content areas (Luiten, Wilbur & Ackerson, 1980). Others have concluded that “the efficacy of advanced organisers has not been established” (Barnes & Clawson, 1975, p. 651). It may be more productive in the context of this study to acknowledge this debate rather than participate in it. Rather, the focus for the current study is upon the essence of Ausubel’s theory as summarised by his statement that “the most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly” (Ausubel, 1968, page vi). To apply this idea, teachers and instructional designers must identify the relevant concepts that are part of the learner’s existing knowledge or as Ausubel (1968) explained, identify the relevant subsuming concepts that are available in the learner’s cognitive structure.

Ausubel conceived of cognitive structure as highly organised linkages formed between elements of information stored in the brain. While such a structure is idiosyncratic, it is highly ordered, forming links between various older and newer elements of knowledge (concepts). This conceptual hierarchy contains minor
elements of knowledge that are linked (subsumed) under more general, more inclusive concepts. Thus a cognitive structure represents a framework of hierarchical organising concepts which depict an individual's organisation of experience. Every individual has a unique history and any specific element of an individual's cognitive structure is idiosyncratic. As new experiences occur new knowledge is related to concepts already in a person's cognitive structure. These concepts become elaborated or altered so that they can be linked to a wider array of new information in subsequent learning. Such a process is described by Ausubel as concept differentiation (Ausubel, 1963). This aspect of Ausubel's work suggests that it is not a simple task to ascertain what the learner already knows. Therefore we may need to look at the problem of ascertaining what the learner already knows from a different perspective as traditional methods of testing reveal little, if anything, about the learner's cognitive structure.

The second part of Ausubel's statement about learning mentions to "teach him accordingly". Individuals can learn information that bears little or no association with existing concepts. But Ausubel (1968) argued that meaningful learning occurs when new information is linked with existing concepts. When this happens he claims that the new information is more likely to be successfully retrieved from long term memory. Ausubel (1968) suggested that we might begin instruction with the most general concepts, but we need to show how they are related and need to move up and down the concept hierarchy in order to illustrate links between concepts. Such an approach is called expository teaching. While other researchers supported the notion that learning materials should be ordered in some sort of discipline-determined logical order they reported no evidence to support the use of an organisational
THEORIES OF LEARNING AND INTERACTIVE MULTIMEDIA

Constructivism may be regarded as a philosophy and one that reduced the traditional instructional design process. Cognitive tools also tend to have reduced the design requirements. Instead of specialists such as instructional designers using technology to constrain students' learning processes through prescribed communications and interactions, the technologies are taken away from the specialists and given to learners to use as media for representing and expressing what they know. Jonassen (1996) suggests that learners themselves function as designers using technologies as tools for analysing the world, accessing information, interpreting and organising their personal knowledge, and representing what they know to others.

A constructivist approach to learning is based upon the view that as learners interact with the world, they contract their own experience and knowledge (Lyddon & McLaughlin, 1992; Novak, 1988). Thus, learning is viewed as "the product of self organisation" (von Glaserfeld, 1989, p. 136). This learning process is supported by two broad principles: firstly knowledge is not passively received but actively constructed by the learner and secondly, learners generate understanding when they relate prior knowledge to present experiences (Wheatley, 1991). Often this occurs when the learner attempts to reconcile differences that exist between her/his explanation and the explanations of others about the same phenomena (Osborne & Wittrock, 1985; Posner, Strike, Hewson & Gertzog, 1982). Such a process often involves intensive and
extensive interpersonal negotiation (Osborne & Wittrock, 1985; von Glaserfeld, 1989) of learners' ideas and beliefs as learners interact with their world.

Researchers in the field of science education have conducted extensive reviews of the research on learners' ideas and beliefs (Osborne & Wittrock, 1985; Driver et al., 1994) and they have consistently found that when learners come to science they already hold explanatory views of phenomena. These views are tightly held and can be remarkably unaffected by traditional forms of instruction. Particular views can be quite common and these ideas/beliefs are often remarkably consistent across groups differing in age and nationality.

The review of the literature focuses on science education because of the long history of research into the nature and importance of the ideas that children can bring to the science classroom. The context of the current study focuses on a science class. Tobin, Tippins Gallard (1994) state that “although constructivism is not a new way of thinking it has not been accepted as the prevalent way to conceptualise knowledge by the community of educators” (p.46). They claim that the education community seems to be involved in a process that is similar to what Kuhn (1962) called a paradigm shift. While constructivism may not have been accepted a decade ago, there are now efforts to understand constructivism across all areas of education. Such a paradigm shift in cognitive theory challenges researchers to develop new techniques for educational inquiry.

Driver (1988) argues that instruction that is based upon a constructivist perspective has to take into account findings relating to learner’s ideas and beliefs and there are various features which
may be seen to be characteristic of such a perspective. She stated that:

• Learners are not viewed as passive but are seen as purposeful and ultimately responsible for their own learning. They bring their prior conceptions to learning situations.

• Learning is considered to involve an active process on the part of the learner. It involves the construction of meaning and often takes place through interpersonal negotiation.

• Knowledge is not ‘out there’ but is personally and socially constructed, its status is problematic. It may be evaluated by the individual in terms of the extent to which it ‘fits’ with their experience and is coherent with other aspects of their knowledge.

• Teachers bring their prior conceptions to learning situations not only in terms of their subject knowledge but also their views of teaching and learning. These can influence their ways of interacting in classrooms.

• Teaching is not the transmission of knowledge but involves the organisation of the situations in the classroom and the design of tasks in a way which promotes scientific learning.

• The curriculum is not that which is to be learned, but a program of learning tasks, materials and resources from which students construct their knowledge (Driver in Fensham, 1988, p. 138).

These principles have been applied to the design of the software package *Exploring the Nardoo* (Harper, 1996), presentation and use of the genre templates used for the current study.

*Principles and views currently held*

Roblyer (1996) suggested that constructivist strategies are based on principles of learning that were derived from branches of cognitive science. This area focused specifically on students’ motivation to
learn and their ability to use what they learned outside the "school culture." Constructivist strategies attempt to account for and remedy perceived deficiencies in behaviourist and information processing theories and the teaching methods based on them.

Despite the current popularity of constructivism, its principles and practices have also been stimulated by a variety of criticisms. More interest than ever before is also focused on carrying out research to measure the impact of learning based on student problem solving and product development (Cognition and Technology Group at Vanderbilt, 1995). This has resulted in some dramatic shifts in curriculum goals and methods that followed constructivist principles. New innovations and restructuring of the curriculum was called for by researchers and educators.

Jonassen (1996) suggested that calls for changes in today's schools frequently focus on the need to re-emphasise student problem-solving and higher order thinking skills. To facilitate the development of these skills, he emphasises that,

... learning and teaching must shift from a knowledge transfer process instructivism to a knowledge building process constructivism. An example of this would be seen in traditional instruction where "active" refers to stimulus, response, feedback and reinforcement in conditions that help students mirror accepted views of reality. In constructivist learning environments however, "active" learners participate and interact with the surrounding environment to create their own interpretations of reality (Jonassen, 1996, p. 56).

Fosnot (1996) further supports constructivism, although not as a theory of teaching. He states that,

... a constructivist view of learning suggests an approach to teaching that gives learners the opportunity for concrete,
contextually meaningful experience through which they can search for patterns, raise their own questions, and construct their own models, concepts, and strategies. The classroom in this model is seen as a minisociety, a community of learners engaged in activity, discourse, and reflection. The traditional hierarchy of teacher as the autocratic knower and learner as the unknowing, controlled subject studying to learn what the teacher knows begins to dissipate as teachers assume more of a facilitator's role and learners take on more ownership of the ideas. Indeed, autonomy, mutual reciprocity of social relations, and empowerment become the goals (p. 9).

Cunningham, Duffy & Knuth, (1993) and Knuth & Cunningham, (1993) describe seven goals for the design of constructivist learning. These are to:

- provide experience with the knowledge construction process;
- provide experience in and appreciation for multiple perspectives;
- embed learning in realistic and relevant contexts;
- encourage ownership and voice in the learning process;
- embed learning in social experience;
- encourage the use of multiple modes of representation;
- encourage self-awareness of the knowledge construction process.

These pedagogical goals offer a framework for the design of a constructivist learning environment. Designers who use these goals to support the theoretical bases of their practice are likely to create constructivist learning environments. However, it is the interpretation of these goals and their subsequent translation into learning activities that are the real design challenges for constructivist learning environment designers.
Dunlap and Grabinger (1996) have come up with constructivist values that are consistent with goals stated by educators attempting to restructure the way students learn. These are known as REALS (Rich Environments for Active Learning in the Higher Education Classroom). REALS are based on constructivist values including "collaboration, personal autonomy, generativity, reflectivity, active engagement, personal relevance and pluralism" (Lebow, 1993, p. 5). Several other researchers share the view that constructivist learning environments provide opportunities for learning activities in which students, instead of having knowledge transferred to them, are engaged in a continuous collaborative process of building and reshaping understanding as a natural consequence of their experience and interaction with the world (Goodman, 1984; Forman & Pull, 1988; Fosnot, 1989).

A holistic approach to educational constructivist learning environments reflected the assumption that the process of knowledge and understanding acquisition is "firmly embedded in the social and emotional context in which learning takes place" (Lebow, 1993, p. 6). These types of constructivist beliefs are also strongly represented in the concepts of intentional learning (Scardamlia et al., 1989), authentic activity and situated cognition (Brown, Collins & Duguid, 1989) and in such constructivist-based learning and instructional theories as cognitive flexibility (Spiro et al., 1991) and cognitive apprenticeship (Collins, Brown, & Newman, 1989). Nevertheless, constructivist beliefs, being strongly represented in the learning theories mentioned above, need to be continually researched and supported to improve the learning environment.
Dunlap and Grabinger (1996) also state that students should be frequently encouraged to reflect on the processes they are using during their learning process, to compare one strategy to another and to evaluate the effectiveness of a strategy for the particular learning activity the students are engaged in. They should be stopped and asked questions like, "What are you doing? Is it working? If it isn’t what are your other options?" In other words, students need to be given time to reflect on their thinking processes by asking themselves questions (or being prompted by the instructor or peers) for help. One way of doing this is by providing scaffolds in electronic form, as questions, such as:

• Which strategies did you use? which ones worked? which ones didn’t work?

• What would you do differently next time?

• What would you do similarly next time?

• What was your single, most important difficulty in solving the problem?

• Did you start by looking at the overall problem, or did you immediately break the problem down into smaller chunks?

• What would you do differently if you had more time and resources to work on the problem? less time and resources?

Glaser (1990) supported the notion of Dunlap and Grabinger that indicated a shift in instructional theory from an emphasis on performance to an emphasis on learning due to the growing demands for people who are able to think and reason in novel settings. This shift focuses our attention on helping students to construct knowledge and understanding for themselves rather than teaching them specific information (Spiro & Jehn, 1990). One way of
doing this is to provide learners with cognitive support based on constructivist principles and values.

Up to this time the focal point of education has been slowly shifting from students remembering bits of information to students being able to consciously construct conceptual understanding that links the bits into patterns of information. The cognitive revolution is based on building students' capacities to integrate knowledge, in marked contrast to a still popular but slowly fading behavioural learning paradigm. The case for constructivism has been made.

Hyerle (1996) provided us with a practical view to the central problem of constructivism, suggesting that we can create the environment for constructivist learning but we still need to understand the learning processes.

The central problem that constructivist educators face is not a guiding theory, but concrete strategies and tools for institutionalising these theoretical and practical understandings into more inclusive classrooms. Some constructivist approaches are entering classrooms slowly, such as cooperative learning and conflict resolution, thinking and process writing instruction, integrated and interdisciplinary approaches and portfolio and performance based assessment practices. But we are just beginning to articulate how these designs work together and notice that most of these approaches create the environment for constructivism but do not centre explicitly on how an individual learner constructs knowledge (Hyerle, 1996, p. 37).

To identify further how learners construct knowledge the current study investigates concrete strategies (metacognitive processes) and tools (genre templates) for a practical understanding of learning in the classroom. The current study also sought to explicitly centre on how learners construct knowledge by looking at their cognitive styles and approaches. Two instruments that were Fused for this
are the Learning Process Questionnaire (LPQ) by Biggs and the Group Embedded Figures Test (GEFT) by Witkin, Oltman, Raskin & Harp, (1971).

**Environments**

There are several studies to date that have already researched the learning process using constructivist principles, some of these are discussed below. Wilson (1995) describes a framework for Study Support Environments (SSE) design and its application to three specific SSEs created as part of the Interpretation Construction (ICON) Design Model. This model consists of the following:

- Observation: Students make observations of authentic artefacts anchored in authentic situations.

- Interpretation Construction: Students construct interpretations of observations and construct arguments for the validity of their interpretations.

- Contextualisation: Students access background and contextual materials of various sorts to aid interpretation and argumentation.

- Cognitive Apprenticeship: Students serve as apprentices to teachers to master observation, interpretation and contextualisation.

- Collaboration: Students collaborate in observation, interpretation and contextualisation.

- Multiple Interpretations: Students gain cognitive flexibility by being exposed to multiple interpretations.

- Multiple Manifestations: Students gain transferability by seeing multiple manifestations of the same interpretations.

Some of these constructive design principles are adaptations from proposals by others. For example, the Cognitive Apprenticeship
principle comes from Collins, Brown and Newman (1988), Multiple Interpretations from Spiro, Feltovich, Jacobson and Coulson (1992), and Collaboration from Johnson, Johnson, Holubec and Roy (1984). The Observation principle is a combination of recommendations by Brown, Collins and Duiguid (1989) and the Cognition and Technology Group at Vanderbilt (1990); the model focus on authentic artifacts is unique. Further, their emphasis on Interpretation Construction, Contextualisation, and Multiple Manifestations is distinctive.

To illustrate the application of this design framework, two SSE programs were created for the Dalton Technology Plan. There were two studies in that describe how these constructive design principles were applied. They include the Archaeotype program used in 6th grade history, the Galileo program used in 11th and 12th grade science (particularly for students not scientifically oriented).

Summary of study support environments

The above researchers believe that interpretation is central to cognition and learning; they evaluated whether the Archaeotype and Galileo SSE programs would increase students’ interpretation skills. They tested whether the students who had been through these programs could make observations and interpretations in a completely new area better than students who had not been through the programs.

The archaeotype program

In the Archaeotype evaluation study, 6th grade students who had participated in the Archaeotype program and a comparable group of students that had not participated were each given a booklet
describing four psychology experiments examining how people remember lists of words. The students had to examine the basic observation report on the results of the studies, find patterns in the results, devise explanations and argue for those explanations. They were also given some background readings in the psychology of memory. The reports the students wrote were then scored for how many they identified of the 60 possible points available for recognising the patterns in the data, representing the data in insightful ways, explaining the patterns of results and arguing for the explanations. The students who had been through the Archaeotype program achieved 42% of the possible points after 4 hours work, whereas the non-Archaeotype students only achieved 32%. Most striking, was that almost all of this superiority was due to the Archaeotype students scoring 45% of the possible points on the explanation and argumentation part of the scoring, while the non-Archaeotype students scored 26% on this portion these two differences are highly significant statistically. Clearly, in addition to learning about archeology and ancient history, the Archaeotype students were acquiring a general ability to interpret and argue in new areas of study.

The galileo program

The 11th and 12th grade students who had been through the Galileo program were compared to a control group. The criteria for a comparison was how well students could interpret and link three related cognitive psychology studies and underlying principles of the studies. They were given booklets containing descriptions of basic observations made in these three psychology studies together with various informational resources including relevant and irrelevant background material.
The students were given three hours to perform the task and write a final report. As in the previous study, these reports were scored for the following points, necessary: recognising patterns in the data; representing the data; interpreting the data and arguing for the interpretations. As in the preceding study the students who had been through the Galileo program were much better than students who had not been through the program with the Galileo students scoring 44% of the possible points and the non-Galileo students only 32%. This difference is statistically high in fact, the Galileo students showed superiority in all four areas scored namely: pattern recognition, data representation, interpretation and argumentation. Clearly, the Galileo program, like the Archaeotype one, teaches students general interpretation skills in addition to specific content.

While the researchers designed the evaluation studies as appropriate for what they were trying to accomplish with the SSEs, it is instructive to examine the studies in terms of the constructivist learning evaluation criteria proposed by Jonassen (1992). The researcher’s evaluations were goal-free since they did not look for particular interpretations by students but merely how well formulated and argued their interpretations were. Nevertheless, evaluations also met Jonassen’s criteria of using authentic tasks (the students interpreted actual psychology experiments and results), involving knowledge construction (the students constructed the interpretations and argumentation), being context-driven (students were evaluated in the context of making sense of psychological observations), involving multiple perspectives (different interpretations were proposed and argued by different students) and involving socially-constructed meaning (the students worked in groups to make sense out of the observations). Table 2.1 provides a
comparison of constructivist views from Jonassen and the studies discussed.

Table 2.1: A comparison of constructivist views

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<th>Jonassen</th>
<th>The Studies</th>
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<tr>
<td>• goal free</td>
<td>• argument</td>
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<td>• authentic tasks</td>
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<td>• involved knowledge construction</td>
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<td>• involving multiple perspectives</td>
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<td>• involving socially constructed meaning</td>
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The current research study does not seek to represent nor to replace the study Support Environments research. However, it is important to note factors not accounted for by these studies. These factors included the three criteria that Jonassen had proposed. The evaluations did not demonstrate that evaluations should be process-oriented and multimodal (for simplicity they merely evaluated the end-product report of the students’ deliberations), and that the goals of the evaluation should be set by the learners. In contrast, software such as Exploring the Nardoo supports constructivist principles by using multiple media representations in context. Learners participated in setting their own assessment criterion.

Authors of Exploring the Nardoo, the Galileo and the Archaeotype programs propose an approach to constructivist design that makes interpretation construction of authentic artefacts in the context of rich background materials the central focus. The preceding studies and studies of children’s use of Exploring the Nardoo (Harper, Hedberg, Corderoy 1997) have shown how this approach can be applied to Study Support Environment programs in widely different fields of study; namely, history, science and literature. They have
also shown that in addition to learning specific content, students using these programs acquire generalisable interpretation and argumentation skills. Thus, their constructivist design framework is useful both for guiding design and for producing valuable learning results. The current research study uses the guiding principles of observation, interpretation construction, contextualisation and multiple interpretations. The current study will consider the issues of interpretation and goals or outcomes set by the students in a constructivist learning environment.

Open ended learning environments

Another learning environment that is similar to the Study Support Environment programs which share a constructivist epistemology in an open-ended learning environment (OLEs) supported by student centred approaches to learning. Knowledge and context are inextricably connected. Meaning is uniquely determined by individuals and is experiential in nature. The solving of authentic problems provides evidence of understanding. OLEs are concerned with the understanding of knowledge construction and representation as opposed to the recall of knowledge.

Much of the criticism surrounding traditional instruction is that it often stresses recalling information rather than understanding complexities. Open-ended learning environments immerse learners in experiences that foster understanding through extended exploration, manipulation and opportunities to “get to know” an idea, rather than simply being told about it (Papert, 1993). Interactions emphasise the underlying reasons “why” an idea or concept exists instead of simply acknowledging or accepting its validity. Understanding transcends the literal information given. It
is augmented by personal experiences, points of view and cognitive scaffolding (Hannafin. et al., 1994, p. 52).

Interest in OLEs has grown dramatically over the last five years. However, there remain many unresolved issues in the areas of research, development and implementation. Hannafin et al., (1994), claimed that when study outcomes are explicitly specified and emphasised within traditional frameworks, it is doubtful that systems will out-perform well designed directed learning lessons. OLEs are designed to promote fundamentally different kinds of learning. Research methods need to reflect the intention of the environments. The different kinds of learning outcomes need to be better understood and methods for assessing the successes or failures of such systems (as well as competing systems) need to be developed.

Hannafin et al., (1994) suggested that we need to explore further how to design and develop varied types of learning environments. Unlike well established IDS methods, and directed learning strategies, there is a very weak design science for such systems. Much of the evidence is case study based, rooted in research and design prototypes which appears to be a method for explaining the features of a product. They may or may not be applicable in creating parallel environments. We know that tools and resources are needed, that contexts need to be authentic and cognition-situated, and that the learner should be required to actively generate and construct knowledge, but to date we have only isolated case studies and heuristics to assist in design. The authors of OLEs agree with previous researchers in that finally we need to better understand how to structure contexts for learning, then
make accessible the knowledge, tools and resources needed to be productive within each context (Hannafin et al., 1994).

Constructivist teaching and learning

Although there is general agreement on the basic tenets of constructivism, the consequences for teaching and learning are not as clear cut. It is generally agreed that learning involves building on prior experiences, which will differ from learner to learner. Consequently, it can be argued that each learner should have a say in what they are to learn. Different learning styles must be catered for and information must be presented within a context to give learners the opportunity to relate new learning to prior experience. The process of learning is an active one, so the emphasis should be on learner activity rather than teacher instruction. More moderate constructivists claim that formal instruction is still appropriate, but that learners should then engage in thought-oriented activities to allow them to apply and generalise the information and concepts provided in order to construct their own model of the knowledge (Perkins, 1991). During the conduct of the current study learners had the opportunity to actively engage in the learning process by exploring an information landscape via embedded resources, choice of task and the use of a variety of cognitive tools as support for the writing process.

Moshman (1982) presents another interpretation of constructivism and has labelled the forms as endogenous, exogenous and dialectic; endogenous constructivism emphasises the individual nature of each learner’s knowledge construction process, and sees the role of the teacher as being merely to facilitate disequilibrium occurring; by providing appropriate experiences. Exogenous constructivism is
the view that formal instruction can help learners to form knowledge representations which they can later accommodate to their subsequent experiences. Dialectic constructivism is the view that learning occurs through realistic experience, but that learners require scaffolding provided by teachers or experts as well as collaboration with peers.

Rather than seeing these categories as being mutually exclusive, it is more informative to think of them as being points on a triangle, with any particular view of constructivism drawing on influences from all three, but positioned nearer to one point than the others. The diagram in Figure 2.1 illustrates this idea, showing where a range of constructivist pedagogical theories lie in relation to these categories. The theories shown in the diagram are Wittrock’s Generative Learning (1974), Bruner’s Discovery Learning (1962), Brown, Collins and Duguid’s Situated Cognition (1989), Cognition and Technology Group at Vanderbilt’s Anchored Instruction (1991), Whole Language Teaching (Goodman and Goodman, 1990), Spiro, Feltovich, Jacobson and Coulson’s Cognitive Flexibility Theory (1991), Ausubel’s Expository Teaching (McInerney and McInerney, 1994), Metacognitive Strategies (Wittrock, 1994), Scaffolding (Bruner, 1986) and Cooperative Learning (Johnson and Johnson, 1994).
Figure 2.1: Constructivist pedagogical theories

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Dalgarno (1996) reviewed the three main areas of constructivist techniques and suggested where each of the educational theories may fall by incorporating the use of metacognitive strategies. The three views of constructivism emphasise the importance of individual knowledge construction. A consequence of this emphasis is the use of metacognitive strategies; that is strategies employed by the learner to improve their comprehension, retention and individual construction of knowledge. These strategies are considered particularly important by exogenous constructivists, who typically advocate that these strategies be directly taught to students. It has been proposed that the use of computer-based cognitive tools can be of assistance with these strategies. According to Jonassen, such tools “amplify thinking and facilitate knowledge construction” (Jonassen 1992a, p. 4).

The current research has adopted the views of Dalgarno (1996) that cognitive tools can be of assistance with metacognitive strategies. The current study however, did not attempt to address the question of whether these strategies should be overtly taught or overtly discovered.

Duffy and Cunningham (1996) listed seven metaphors we teach by as basic assumptions for design. These include that,

- all knowledge is constructed; all learning is a process of construction;

- many world views can be constructed: hence there will be multiple perspectives;

- knowledge is context dependent, so learning should occur in contexts to which it is relevant;

- learning is mediated by tools and signs;
learning is an inherently social-dialogical activity;

• learners are distributed, multi dimensional participants in a sociocultural process;

• knowing how we know is the ultimate human accomplishment.

To their original list Duffy and Cunningham (1996) have added a new element, "learning is mediated by tools and signs". This consideration implies that the tools (technology) and signs (semiotic tools) we use change the form, structure and character of activities and thus our knowledge. The last of the seven metaphors, 'Knowing how we know is the ultimate human accomplishment', is explored by the current study which concentrates on learner use of metacognitive strategies while using the genre templates that have been presented in electronic format.

In order for designers to adopt these frameworks, they will need to reassess the instructional design paradigms they are using. It would seem no longer sufficient to use the traditional hierarchical, prerequisite sequences (learning taxonomies) that concentrate on recall and application of knowledge. Jonassen and Tessmer (1996/7) have described a taxonomy that "elaborates structural and higher order cognitive, metacognitive and motivational learning outcomes that are not included in the currently-used taxonomies of learning outcomes." (p. 9).

It can be argued that if researchers are to base learning environments on the framework that Duffy and Cunningham have proposed then appropriate learning outcomes associated with this view of learning will need to be devised, and no longer should researchers rely on the behavioural bias of current instructional
design models. Jonassen and Tessmer (1996/7) have proposed that researchers need to develop strategies that support:

• active learners to engage in interaction with and manipulation of the exploration environments that we construct;

• learners to explore and strategically search through these environments;

• intentional learners willingly trying to achieve cognitive objectives;

• conversational learners engaged in dialogue with other learners and with instructional systems;

• reflective learners articulating what they have learned and reflecting on the processes and decisions that were included in the process;

• ampliative learners who generate assumptions, attributes and implications of what they learn.

The impact of increased use of constructivist based methods with learners includes: increased learner independence; greater learner responsibility and control; increased emphasis upon shared knowledge and decision making, and the development of a coaching and mentoring relationship among teachers and students (Goodrum, Dorsey & Schwen, 1993; von Glaserfeld, 1989). However such changes in the classroom may not be liked by all students and teachers and concerns about constructivist approaches to learning have been raised by authors such as Matthews (1994; 1997). Matthews (1994) argues that constructivism “radically underestimates the degree to which individual cognition and thought is dependent upon social reality” (p. 6). This criticism may have been a valid comment about some of the more radical neo-Piagetian-based approaches to personal constructivism, but as the
movement has evolved toward social constructivism which emphasises the social context of the learning situation where learner interaction and cooperative learning are seen as integral parts of the process (Wilson, 1993; Wittrock, 1990; von Glaserfeld, 1989; Vygotsky, 1978) the criticism is perhaps no longer as pertinent. This point has been acknowledged by Matthews in recent articles, however he maintains constructivist learning theory "is simply getting in the way of good teaching" (Matthews, 1997. p. 13). For the purpose of the current study the term constructivism recognises the importance of social interaction in learning. This involves the use of language (von Glaserfeld, 1989) and it is through such a process that we "have our experiential reality confirmed by others" (von Glaserfeld, 1989, p. 130). Genre templates used in the current study have been incorporated into a constructivist learning environment with their impact on student learning identified.

Harper and Hedberg (1997) believed that;

...many writers have sought to develop guidelines for developers of software that will support new modes of learning. By examining educational products developed within these frameworks we can review the effectiveness of the application of new schema for categorising learning outcomes" (p. 24).

In comparing these later models with earlier constructivist models the level of progress from directed to non-directed approaches to instruction, learning and the use of resources can be clearly seen.

In previous studies little consideration was given to how learners experience constructivist learning (Goodrum, Dorsey & Schwen, 1993). For example, problems arise as the approach may place a high cognitive load upon the learner because the learner is expected
to manage her/his own learning; yet the learning process may or may not be familiar to the student. Learners often feel less secure than in traditional environments as they like to stay with familiar routines and find the reluctance of the instructor to tell them exactly what to do in specific situations frustrating.

However, researchers such as Collins (1990) have identified trends in school-based instruction with technology which they contend will provide better support for constructivist learning (Cognition & Technology Group, 1991; Wilson 1993; Tobin et al., 1994). The trends identified include: a shift from lecture and recitation to facilitation and coaching; a shift from working with better students to working with all students; a shift toward more engaged students; an assessment based on process, products, progress and effort; a shift from a competitive to a social structure; a shift from all learners learning the same things to different students learning different things; and a shift from verbal thinking to the integration of visual and verbal thinking.

To successfully apply a constructivist approach in the context of the current study, the research process needed to address the issues raised in the previous paragraphs and the role of learner use/non-use of the genre templates. This approach is consistent with a constructivist approach to learning and should improve the usefulness of the genre templates within the software package to help learners provide a more synthesised response to a writing task. The current study has taken on this challenge of how we answer the question of implementing the class of theories referred to as constructivist technology supported learning environments.
Situated cognition

Situated cognition emphasises higher order thinking skills over memorisation of factual information. It involves strategies in the form of metacognitive monitoring of progress toward a solution, and the reasoning experienced, in real world problem solving. Situated learning environments induce inferential reasoning, monitoring and regulation of problem solving and utilisation of metacognitive strategies (Winn, 1993).

Situated learning systems focus on growth, primarily in student cognition. The Cognition and Technology Group at Vanderbilt (1993), for example, suggested that a primary goal of situated learning was to allow students (and teachers) to experience the effects of new knowledge on their perception and understanding of their environments. They wanted students,

... to experience what it is like to grow from novices who have only a single viewpoint to relatively sophisticated experts who have explored an environment from multiple points of view (Winn, 1993, p. 9).

Students construct understanding through exploration rather than being taught specific knowledge (Winn, 1993). The student moves from the organisation of content and sequence to the creation of environments that induce, then facilitate, understanding.

In addition, since situated learning requires a change of the teacher's role from a knowledge transmitter to a coach or facilitator of students' understanding, more and better guidance is required (Bender et al., Duffy & Jonassen, 1991: Winn, 1993). Situated Cognition proposes a radically different explanation of learning, conceiving it as a largely social phenomenon. Rather than occurring
within the mind of the individual learner, it is instead described as a characteristic of many social interactions that take place within a frame work of participation (Harley, 1993).

Theories of situated cognition take the view that human activity is complex, involving social, physical and cognitive factors. Proponents of these theories believe that rather than acting on symbolic representations of the world that are located in the mind, we are in direct contact with the environment. Therefore cognitive representations only become necessary when normal situated activity fails (Dreyfus and Dreyfus, 1986 and Greeno 1989). Rather than viewing knowledge as internal to the mind, situated cognition suggests that knowledge is a relationship between an individual and a social or physical situation. This does, however, depend on other variables such as context and situation meeting the needs and demands of the learner.

**Context and situation**

It is often argued that context and situation are all important in providing for learning at all levels and should influence in particular the design of instructional multimedia (Herrington & Oliver, 1995). Collins (1989) described situated learning thus: "situated learning is the notion of learning knowledge and skills in contexts that reflect the way the knowledge will be useful in real life" (p. 2). In the same context, Collins, Brown and Newman (1987) suggested that,

... teaching methods be designed to give students the opportunity to observe, engage and invent or discover expert strategies in context so that they might best learn both cognitive and metacognitive skills (p. 12).
Since learning is assumed to be indexed by personal constructions of reality, experience is fundamental to understanding and using knowledge and skills. In Situated Learning Environments, students are provided support to facilitate personal constructions of meaning about the world they experience and ongoing, interactive and continuous facilitation is provided.

The role of facilitation provides learners with opportunities for internalising information thereby promoting higher order metacognitive skill development (self monitoring and correction skills) as well as self regulation and self assessing abilities. In Situated Learning Environments, facilitation has assumed several forms: modelling, scaffolding, coaching, fading and using cognitive tools and resources. In the current study the learning environment is situated (socially and physically) and the focus is upon scaffolding. Scaffolding is characterised by introducing genre templates into an information landscape to promote higher order metacognitive skill development.

**Scaffolding**

Greenfield (1984) characterised five benefits of scaffolding, a metaphor adopted from building construction:

- It provides a support.
- It functions as a tool.
- It extends the range of the worker.
- It allows the worker to accomplish a task not otherwise possible and
- It is used selectively to aid the worker where needed.
Scaffolds are not needed when cognitive structures are sufficiently developed; they are needed while the structures are incomplete or unstable (Brown & Palinscar, 1989). By supporting the integration of established understanding and know-how, scaffolds facilitate the transfer of what students already know to the task at hand (Harley, 1993). For the purpose of the current research, genre templates have been used as scaffolds to support students in further developing their cognitive structures. The software program *Exploring the Nardoo* as a learning environment provides a context and situation in relation to a task and facilitation through embedded technological resources. In addition, the genre templates used for this research are (Harper et al, 1997) thought to provide support to learners as scaffolds during the learning process.

Scaffolding supports and simplifies a task as much as is necessary to enable learners to manage their learning, allowing them to accomplish otherwise impossible tasks. This involves maintaining optimal challenge: too little challenge will prove boring, while too much will foster frustration (Brandt, Farmer & Buckmaster, 1993). Thus scaffolding closes the gap between task requirements and skill levels by “creating the match between the cognitive level of the learner and the characteristics of instruction” (Greenfield, 1984, p. 188). Scaffolding ranges from performing an entire task to providing occasional hints. Scaffolding can be reduced, reorganised or eliminated as learners become more complete in their understanding.

Instruction occurs in the interaction between novice and expert, who together structure their communication so that the novice is brought into the expert’s more mature understanding of the problem. The expert modifies the scaffold as the novice’s
capabilities develop, adjusting support to a level just beyond that which the novice could independently manage (Rogoff & Gardner, 1984, p. 116).

This may be regarded as extending Vygotsky's (1978) "zone of proximal development" wherein the novice, with the support of experts (human or technological) achieves what cannot be achieved autonomously (Salmon, Globerson, & Guterman, 1989). The genre templates in the current study provided the researcher with a way of trying to create the match between the cognitive level of the learner and the characteristics of instruction when in an electronic information landscape and using a variety of multimedia to form a response to a given task.

Scaffolds may also be used by expert students as part of the planning process and as part of higher order thinking skills in situated learning environments. Hannafin (1997) argues for this in open-ended learning environments (OLEs). When enabling contexts and problems are supplied, scaffolding can be closely linked to the domain under study; when enabling contexts are individually generated, scaffolding of a generic nature is generally provided. OLE scaffolding may or may not be faded as facility is attained. For individual uses, where the nature of use and learner needs cannot be established in advance, scaffolding typically remains available but its usage becomes less frequent as the learner's facility increases (Hannafin, 1997, p. 12).

There are many types of scaffolding as defined by Hannafin (1997). These include conceptual, metacognitive, procedural and strategic scaffolding. The current study draws upon a combination of metacognitive, conceptual and strategic scaffolding by including the use of embedded genre templates, within an interactive multimedia
learning environment (*Exploring the Nardoo*), during the learning process.

*Metacognitive Scaffolding*

Metacognitive scaffolding supports the underlying processes associated with individual learning management. It provides guidance in how to think during learning. Metacognitive scaffolding can be either domain-specific, such as where enabling contexts are externally induced, or more generic where the enabling context is not known in advance. The process of scaffolded inquiry helps students to consider how or if to initiate, compare, and revise their representations. Metacognitive scaffolding might also remind learners to reflect on the goal(s) or prompt them to relate a given resource or tool manipulation outcome to the problem or need at hand (Hannafin, 1997, p. 13).

*Conceptual Scaffolding*

Conceptual scaffolding is provided when the problem under study is defined for externally-imposed or self-induced enabling contexts. When problem parameters and domains are established externally, it is possible to anticipate methods that are sensitive to the demands of the area under study. Known and widespread science misconceptions, for example, provide a powerful foundation for predicting likely conceptual difficulties and embedding support accordingly. Conceptual scaffolding can be designed to help learners reason through complex or fuzzy problems, as well as for concepts where known misconceptions are prevalent. In the current study hints via guides and the presence of the genre templates can conceptually guide the learner to available resources, or tool manipulations might be suggested where understanding is typically problematic (Hannafin, 1997, p. 12).
Procedural scaffolding

Procedural scaffolding emphasises how to utilise available resources and tools. It orients to system features and functions, and otherwise aids the learner while navigating an OLE. For example, some learners become disoriented in open-learning environments. Procedural scaffolding is frequently provided, clarifying how to return to a desired location, how to “flag” or “bookmark” locations or resources for subsequent review, or how to deploy given tools (Hannafin, 1997, p. 13). The genre templates used in the current study provided procedural scaffolding by offering a bookmarked workable layout within a desired location of the software package.

Strategic scaffolding

Strategic scaffolding emphasises alternative approaches that might prove helpful. It supports analysis, planning, strategy, and tactical decisions during open-ended learning. It focuses on approaches for identifying and selecting needed information, evaluating available resources, and relating new to existing knowledge and experience. Another type of strategic scaffolding involves alerting the learner to available tools and resources that might prove helpful under given circumstances, and providing guidance in their use. Some OLEs, for example, provide on-demand pools of related questions to consider while evaluating a problem, as well as hints as to which tools and resources might contain the needed information (Litchfield & Mattson, 1989). Expert advice regarding approaches that might be helpful in an OLE can also be embedded. In situated learning, guiding and advising may also be identified as a learning perspective (Hannafin, 1997, p. 13).
The learning environment used in the current study was intended to provide these types of scaffolds. The intention generated a number of issues for consideration:

- Are the students learning with these types of scaffolds?
- Are students aware of the purpose of the scaffolds?
- Are students aware that these scaffolds may help them to organise information?
- Is there a relationship between student approaches to learning and the use of the scaffolds?
- Are students aware that the use of scaffolds may increase their learning and
- Are students aware that through using the scaffolds they may identify other tools for support in organising information?

A review of the literature has revealed "no other" studies which have suggested outcomes for these questions especially in a situated learning environment guided by constructivist principles: when the information is presented with interactive multimedia resources in an information landscape, to provide a written response to a given task. Furthermore, if these questions are resolved, fewer if any studies provide implications for the designers of future interactive multimedia programs.

**Metacognition**

If we can cultivate an awareness in students of their own individual processes of learning we open the door to the ability for them to control their own learning. Constructivist thinkers recognise that the individual's "Notions of truth and proof; notions of uncertainty; notions of fit between knowledge and reality," (Duffy &
Cunningham, 1996; Harrison & Tregust, 1994) have a bearing on how the learner constructs their knowledge. The history of science shows that it is a series of approximations toward a description of reality. Piaget (1971, p. 61) speaks of knowledge as “...not just the acquisition and accumulation of information...” but including the organisation and regulation of information “by means of auto control systems directed toward adaptation, in other words toward the solving of its problem”. Active processing is a skill which needs to be taught. Lorsbach (1992) suggested that “students must learn how to learn”.

Several issues need to be addressed when considering the relationship between metacognition and electronic learning technologies. If students are aware of their metacognitive processes when using interactive multimedia, they will be able to understand the relevance of cognitive support and perhaps start to use a combination of cognitive support tools in ways not yet discovered by teachers and instructional designers. To develop an increased understanding of the learning process for the teacher, students, instructional designers and researchers there is a need to “shift the focus of learning from, as well as getting the right answers in learning, to obtaining the right processes of learning” (McInerney & McInerney, 1995, p. 22). Learners need to consider the appropriate processes of learning that best suits them when using multimedia.

The current study tries to identify one way of cultivating an enhancement of the student’s individual processes of learning by introducing the genre templates into the learning process, so that they may take advantage of using or not using the genre templates at a time that is convenient to her/him. This may or may not
further open the door and provide learners with strategies for controlling their own learning.

Brown, Hedberg and Harper, (1994) further this argument. They explain that theory and experience (Kozma, 1991) suggest the incorporation of prompts and metacognitive support to help users to use these skills that would otherwise remain inert. With developments in communication facilities, experts and advisers can readily be contacted electronically for support. Users should avail themselves of the features of integrated packages, use the outliner capabilities in word processors, use a multimedia database to keep tabs on their resources, access the brainstormer as their rough work space and keep records in their personal electronic diary. With growing computer literacy, these tools are becoming more widely accessed and more selectively used. Metacognition is all about consciousness of one's own cognitive processes; letting others know what strategies to use and share. One way of implementing this idea is by using interactive multimedia programs with embedded cognitive support tools for processes such as writing that promote problem solving skills. This may then enable an increased understanding of how students interact with the genre templates as a means of support for the writing process and during the learning process.

It is necessary (Jonassen, 1997), in all kinds of problem solving, to make a problem solving plan intentionally and to carry out that plan. Planning is an essential executive strategy and provides evidence of metacognition. However, ill-structured problem solving should engage metacognitive processes whereby individuals monitor the epistemic nature of the problems they are solving and the truth value of alternative solutions (Kitchener, 1983), not just
the comprehensive monitoring of metacognitive strategies that serve well structured problem solving. This includes individuals knowledge about the limits of knowing. Epistemic cognition, according to Kitchener, leads one to interpret the nature of the problem and to define the limits of any strategy to solving it (p. 55). From this perspective, in order to solve a problem, the problem solver must first decide if the problem is solvable and whether there exist strategies or processes for solving it. A post-treatment questionnaire has been developed by the researcher to elicit students' responses regarding how they solved the problem.

There is a paucity of evidence which supports the use of metacognitive strategies with the use of cognitive tools in an interactive multimedia learning environment. One study that supports the researcher's views is by Pereira (1996) who examined the beliefs and principles underlying constructivist learning theory through a program called Stepping Out. Stepping Out is a language and literacy program that incorporates Bickmore-Brand's (1994) seven constructivist principles of learning. Pereira (1996) suggested that this project aimed at improving learning outcomes by assisting students to ...use the language of major disciplines more effectively (Education Department of Western Australia, 1995, p. 1). The visible aspects of the Stepping Out program are the strategies. Strategies are underpinned by a set of beliefs that make the strategies most effective. Some of these beliefs are that language as a tool for learning can be used in all subject areas; developmental learning; empowerment of the learner and cooperative group work. The seven principles of learning relate to context, interest, scaffolding, metacognition, responsibility, community and modelling. The Stepping Out program came up with strategies, principles and beliefs about language as a tool for learning; however, they lacked
implementation strategies and activities that are associated with their use in an interactive multimedia learning environment.

Metacognition includes knowledge about monitoring activities designed to ensure that tasks are completed successfully (Shunk, 1991, p. 188). Brown (1997) also agreed with this definition. Her study found that the ability of a learner to set goals, plan, monitor progress, reflect and adapt would certainly assist any complex construction process (p. 6). This review of the literature has found that metacognition is variously defined as having parameters within the areas of knowledge about cognitive states, skills that involve self appraisal, reflection and management of strategies, whether they be content-specific or not within a student-centred environment. These strategies can be included and transferred, dependent upon how they are included in instruction.

Researchers have referred to metacognition as cognitive strategies, (Paris & Winograd, 1990) knowledge about executive control systems (Brown, Harper & Hedberg, 1994), monitoring of cognitive processes (Flavell, 1976), resources and self regulating learning (Osman & Hannafin, 1992) and evaluating cognitive states such as self appraisal and self management (Brown, 1996). These are broad terms that are all equally important depending on the characteristics of the learner and her/his approach to learning. If we look at learners who are aware of their metacognitive processes they will more than likely be people who possess;

self determination or autonomy in learning and problem solving. They will be able to refer to the what, how, when, where and why of learning when carrying out complex cognitive activities.

These will be the learners who do this by:
• planning and deciding what their goals are and what strategies to use to get there;

• decide what further knowledge or resources they need;

• monitoring progress along the way; am I going in the right direction?

• evaluating when I have arrived; and

• terminating when the goals have been met (Biggs and Moore, 1993, p. 307).

Metacognitive awareness is a skill that is associated with successful learners. Successful learners are able to analyse what they are doing, what strategies they are employing and to evaluate their value. Less successful learners never think to try different learning strategies because they don’t realise that the techniques they are using are not as appropriate or effective for the task on which they are working.

We know that what distinguishes expert from novice problem solvers is habituated metacognition; that thinking and discussing thinking begets more thinking and that thinking and problem solving capacities are enhanced when students think aloud, discuss and communicate their thought processes to others (Hyerle 1996, p. 9).

If we now consider how human beings can reflect on their own thinking processes by using resources to plan a course of action, we may envisage the possibility of using genre templates and other technology resources as part of the planning phase for solving a problem. In a liberated multimedia environment, the shift of responsibility to the learners requires the focus to become;
Does the learner possess strategies for exploring this material successfully? In designing democratic multimedia learning environments, the issue becomes not leaving the learner adrift in a sea of content without the tools to be successful and recognising that the metacognitive demand placed on the learner is increased in less structured learning environments (Park & Hannafin, 1993, p. 43).

One method of helping learners respond to greater metacognitive demands is to provide opportunities for checking their own progress and to provide learner guidance about metacognitive strategies. Learners can be reminded about ways to approach materials. These strategies should focus on providing metacognitive prompts and promoting self generated strategies, while weaning the learner from prompts as quickly as possible. Osman and Hannafin (1992) warn against designs in which training in metacognitive strategies requires more energy than the content to be learned. In virtual environments, systems tune themselves to the metacognitive strategies employed by learners, adjust to them and advise the learner of trends that emerge. This environment assumes that programs are sufficiently sophisticated to extrapolate meaningful trends from patterns of learner responses, a type of virtual metacognition not currently widely available in desktop systems.

Metacognitive skills refer to the steps that people take to regulate and modify the progress of their cognitive activity; to learn such skills is to acquire procedures which regulate cognitive processes (Von Wright, 1992, p. 64, cited by Hannafin, 1993)). Metacognitive skills include taking conscious control of learning, planning and selecting strategies, monitoring the progress of learning, correcting errors, analysing the effectiveness of learning strategies when necessary (Ridley, Schutz, Glanz & Weinstien, 1992). These abilities
interact with developmental maturation and domain expertise. Immature learners can’t do this; they may have learned a single strategy, such as memorisation, and then attempt to apply that to all situations. The current research design argues that learners be provided with genre templates as an embedded resource so that those with poor metacognitive skills may have a chance to use these with the help of guides rather than memory only.

Studies show that use of metacognitive strategies can increase learning skills and that independent use of these metacognitive strategies can be gradually developed in people (Biggs, 1995; Brown, 1978; Weinstein, Goetz & Alexander, 1988). Blakey and Spence (1990) describe several basic strategies for developing metacognitive behaviours:

• students should be asked to identify consciously what they know as opposed to what they don’t know;

• students should keep journals or logs in which they reflect on their learning processes, thinking about what works and what doesn’t;

• students should manage their own time and resources, including estimating time requirements, organising materials and scheduling the procedures necessary to complete an activity;

• students must participate in guided self evaluation through individual conferences and checklists to help them focus on the thinking process.

Again studies are suggesting training in metacognition however, they lack implementation strategies within a multimedia software program.

Many studies have reinforced the notion that learners can control and direct their mental processes if they are provided with
cognitive and metacognitive support (Flavell, 1987; Flavell, 1976; Li, 1993; Holley & Danserau, 1984; Jo, 1993). During information processing, metacognitive guidance plays a major role. This guidance may be offered via studies where the focus is to offer that support with the use or non-use of genre templates. Moreover, findings from metacognition research suggest that the development of skills in metacognition will not only help learners to process information, but also to transfer these strategies to new situations (Salomon & Perkins, 1989).

Studies to date have used a variety of research designs and instruments to try to identify students' metacognitive skills and appropriate training models. Biggs, (1987a) details research by Edwards who conducted research with two Hunter Valley classes using the (SHEIK) Study Habits Evaluation and Instruction Kit by (Jackson, Reid & Croft 1980). In this study there was a control class who continued with normal lessons. The experimental classes completed an evaluation of their learning processes using the Learning Process Questionnaire (LPQ) (Biggs, 1987a). This told the experimental students how they were going about the study in comparison to others; the students then individually discussed the possible need for change and how they might go about that.

Edwards then assessed the students' approaches to learning using the Learning Process Questionnaire (LPQ) before and after intervention and later followed up the HSC performance of both groups. The LPQ is an instrument used to assess the extent to which students endorse the more important approaches to learning and the motives and strategies comprising these approaches otherwise known as surface, deep and achieving approaches to learning. These are discussed in more detail in chapter three. She found that the
SHEIK groups both improved their deep approach and achieving approach to learning, while the surface approach remained unchanged, and that their HSC performance was an average of 34 aggregate marks higher in comparison to the control group (Biggs & Telfer, 1987a, 1987b). This raises the issue of the usefulness of teaching learning and thinking strategies and whether there is a best way of doing this (Ashman & Cobway 1992; Jones 1981; Nickerson, Perkins & Smith 1985). This also provides for the notion of teaching thinking skills or reciprocal teaching with reciprocal questioning strategies for enhancing the development of self regulated learning and metacognitive skills in students (McInerney, 1994, p. 226) to promote awareness of learning processes and strategies. The author of the current study feels that the learning process questionnaire (LPQ) by Biggs gave the above study the relevant information on students’ approaches to learning and it will therefore be used in the current study to elicit data on what approaches the learners are taking when they are using the genre templates.

Wagner and Sternberg (1984) also suggest that metacognitive processes might be the direct target of schooling, because these skills are important and have demonstrated a broader degree of transfer than do cognitive strategies. One way of supporting this notion is to not only encourage metacognition learning capabilities but to provide support to individual learners. Identifying how students are using the genre templates would seem one way of investigating that support.

Several closely related studies that have had positive results were studies that used journals. Of particular note where studies in which students kept a journal to help monitor their own learning
The diary shifts the focus of attention from getting the right answers from learning, to using the right processes in learning (McInerney, 1994, p. 22), which is what the current study is trying to demonstrate through the use of embedded cognitive resources and tools. One of these tools is a genre template that may be used by students to help encode information and knowledge that they encounter when synthesising a written response. The study by Houssman (1991), which was a process-oriented study based on the idea that the computer is a tool for the enhancement of metacognitive instruction, confirmed that students became more proficient learners in the computer class.

This was attributed to the students' monitoring of their own learning process. The results of this study contributed to an increased understanding of the metacognitive processes involved in learning and an expanded use of the computer to help students improve their personal learning performance. The learners have ownership of the problem. The facilitation is not knowledge driven; rather it is focused on metacognitive processes.

It is important to investigate the processes of learning. The current study uses the idea of incorporating a diary into the learning process to identify students' appropriate thought processes in learning. However, it is an electronic diary called a personal digital assistant (PDA).

Improving students' metacognitive skills would enhance their approaches to learning. This in turn would increase the structural complexity of students' learning, and the amount of satisfaction derived from it. Research in Australia and NZ, as well as internationally, has been directed towards understanding metacognition and metalearning in the classroom and how these
processes may enhance learning (Anderson & Walker, 1990; Biggs 1987a; Bakopanos & White 1990).

A small amount of research has focused on the way in which the new information technologies can also facilitate the acquisition of both cognitive and metacognitive strategies by the learner in a self regulated manner (DeCorte 1990). This particular research study cites examples of learning with and without metacognition. Two projects that have received attention in NZ and Australia are the project for the Enhancement of Effective Learning (PEEL) and The Study Habits Evaluations and Instruction Kit (SHEIK) cited by Jackson, Reid & Croft, (1980) and White & Baird, (1991). Ongoing Australian studies using PEEL show that students can improve in metalearning as a result of direct teaching of metacognitive skills. However, these studies do not give concrete examples of how metacognitive skills can be taught or supported for students when provided with interactive multimedia software programs in a student centred learning environment.

The researcher also feels that an intervention to teach metalearning skills cannot be long enough as ingrained habits have to be altered as part of the program. These skills cannot be taught as separate lessons (Swan & White, 1990). Part of the program includes supplying students with metacognitive support, embedded resources and identifying how learners are coping with this support. However, there appears to be little research on actually how students use this support.

In a study titled The effect of two different interfaces for database application on problem solving activities (Chen 1993) the problem was to examine the thinking processes students employed while solving ill-structured business problems. Results confirmed that
subjects in both groups demonstrated a similar proportion of metacognitive knowledge, metacognitive experience and executive control in the metacognitive skill used. The current study did not identify what type of learning approaches students had used. Again, if students are demonstrating metacognitive skill use it would be desirable to know what types of students are demonstrating this use so as not to disadvantage students who do not demonstrate it.

Harel's (1991) study detailed the metacognitive activities of one particular subject over a four month period. Harel reported that;

Throughout the research the students were constantly involved in metacognitive acts: learning by explaining, creating and discussing knowledge representations, finding design strategies and reflection (p. 359).

In addition to positive cognitive effects in terms of metacognition, Harel concluded that the students acquired enhanced cognitive flexibility, better control over their problem solving and greater confidence in their thinking abilities. She noted however, that the study did not include any direct measures of thinking skills, that her own interpretations of the students' metacognition and problem solving processes were based upon observations and analysis of documentation such as their designer notebooks.

Flavell (1987) suggests that metacognitive knowledge can be divided into three categories: knowledge of person variables; Knowledge of task and strategy variables; and Knowledge of regulation. Person variables refer to the kind of knowledge and beliefs concerned with what humans are like as cognitive beings (affective, motivational, perceptual); a learner may believe that (s)he is good at dealing with numerical information, but poor at verbal tasks. Task variables relate to how the nature of the
information encountered affects and constrains the ways learners deal with it. For example, a learner may have to take more time to process densely packed information. Strategy variables are used to achieve more than just reaching the cognitive goal or subgoal. A learner may employ a cognitive strategy to compare a series of numbers displayed on a computer screen; such a metacognitive strategy could be to use a sorting tool to rearrange the numbers so that the task was easier to perform. Thus metacognitive strategies are self regulated, conscious experiences that are cognitive and affective; any kind of conscious affective or cognitive experience that is pertinent to the conduct of intellectual life is a metacognitive experience. Person, task and strategy variables interact and we need to understand these interactions (Flavell, 1987). Furthermore, personal growth in metacognitive strategies is often related to an experience and it needs to be recognised that learners need time and experience to better regulate their cognitive processes (Flavell, 1987).

The learner needs to gather evidence to support or reject various perspectives and to support any arguments made for one or another. Solving ill-structured problems, especially international relations problems, requires that learners develop cogent arguments in support of their solutions. The learner must make claims about the probable effects of events, objects, or phenomena on others, warrant those claims, and back them up with supportive statements, facts or conjectures (Voss, 1988). The CD-ROM Exploring the Nardoo provides users with genre templates that may help learners assess the viability of alternative solutions. One of the tasks in Exploring the Nardoo, involves using cognitive tools to support argument construction within an ill-structured domain. Jonassen (1997) suggests that,
Getting learners to make reflective judgements about what can be known and what cannot is important to support in problem solving instruction. That support may take the form of modelling the arguments for the solution to a related problem or prompting learners to reflect on what is known. If modelling is used, it is important that the perspectives of the different problem solvers (both the expert and the Journeymen) be modelled for the learners. Modelling argumentation can also be scaffolded by providing an argument template or argument checklist. The arguments that are developed also provide a valuable assessment of the learner's problem solving ability (p. 60).

Further,

By arguing and counter arguing (with themselves or in a group), learners are defining their problem representations and agreeing on the best course of action. Ill-structured problem solving becomes a process of iteratively restricting alternatives and refining arguments before selecting a solution (Jonassen, 1997, p. 81).

In any learning situation, whether computer managed or human managed, cognitive overload is likely to occur when the total cognitive demand of the task is beyond the learner's ability to process the available information. It is important, therefore, that the learning or the environment be structured to reduce this effect. Active self regulation and purposeful control are needed to keep metacognition active during the learning process, but unsupported learners usually cannot meet the demands of self regulation and purposeful control and suffer cognitive overload.

**Hypertext, multimedia and cognitive load**

Another source of cognitive overload relates to hypertext and multimedia learning environments such as the one used during the current study. The term 'hypertext' was coined by Nelson (1981) to
describe a combination of natural language text with the computer’s capacity for interactive branching, that created a dynamic display of non-linear text which cannot be printed conveniently on a conventional page. Hypertext and multimedia software allows users to explore information in a non-linear and interactive fashion (Barker & Tucker, 1990). The learning environments created by hypertext and multimedia software give the learner access, via computer, to graphics, sound, text, video and animation. The learner can be free to follow her/his own non-linear path through this environment (Nelson, 1981), but without navigational support it is very easy for a learner to become lost in hyperspace and to be unsure about what information they have covered and how it links together (Sewell, 1990; Hammond, 1991).

Doland (1989) assert that cognitive overload in hypertext and multimedia learning environments is related to the degree of complexity of the non-linear learning environment. Variables such as number of choices, task scheduling, tracking guides and navigation aids overload learners short-term and working memories (Jonassen, 1988). Therefore, it is not suprising that researchers propose that hypertext and multimedia learning environments need careful management of the number of user choices in order to facilitate decision making and reduce cognitive load (Liebhold, 1987; Doland, 1989).

Findings from research into learner use of hypertext and multimedia systems by various researchers have revealed a number of problems which can occur (Allonson & Hammond, 1990 Jones, 1987; Ferry, Hedberg & Harper, 1996). Firstly, learners often get lost. The knowledge base may be large and unfamiliar, the links provided will not be suitable for all individuals and for all tasks,
and the users may be confused by the embarrassment of choice. Secondly, learners may find it difficult to gain an overview of the material. They may fail to see how parts of the knowledge base are regulated and may even miss large relevant sections. Thirdly, even if learners know that specific information is present, they may have difficulty finding it. A related problem is that of uncertain commitment where the user is unsure where a link will lead or what type of information will be shown. A fourth problem arises where minimal guidance or constraints are provided as learners are liable to ramble through the knowledge base, in an instructionally inefficient fashion, with their choices motivated by moment-to-moment aspects of the display which attract attention. Thus a system which gives a multiplicity of choice but the minimum of guidance may not be ideal.

When we assist learners to integrate new information from hypertext into their own knowledge structures we need to be aware that the willingness and ability of learners to use their own knowledge structures to assimilate information is dependent on individual differences in such areas as cognitive ability and learning styles (Hammond, 1991). Researchers (Dede, 1990; Barker & Tucker, 1990; Jonassen, 1988; Underwood, 1988) argued about how to structure hypertext to replicate content structures or knowledge structures of learners, and how likely students are to assimilate these structures or accommodate them. For too long authors of instructional software have been plagued with problems such as: where should users begin in a hypertext learning environment; what sort of access structures are needed to guide the user; and how overt should navigation aids be (Hammond, 1991). The focus has been upon designing the hypertext learning environment; to match the ways learners will want to use materials. This could be
related to the degree to which the individual is familiar with the environment, time available, amount of self direction the individual is motivated to assert, together with the amount of change occurring in the environment. Because these variables interact, it is not possible to cater for more than a few sets of circumstances. Jonassen (1992b) argued that rather than develop more powerful teaching hardware, we should teach learners how to think efficiently (p. 2). One way of achieving this goal is to develop cognitive tools that assist learners to process and structure information. The current study argues for this point of view, especially for learners with poor metacognitive strategies due to the complexity of a non-linear learning environment.

Cognitive load theory suggests that effective instructional material directs cognitive resources toward activities that are relevant to learning. It is concerned with the manner in which cognitive resources are focused and used during learning and problem solving. Researchers in the field claimed that many learning procedures engage students in cognitive activities far removed from the ostensible goals of the task, and the cognitive load generated by these irrelevant activities can impede skill acquisition (Chandler & Sweller, 1994, p. 294). For example, mental integration of information with the use of the genre templates requires searching for the appropriate genre amongst other cognitive resources presented in multiple media. This can split learner attention and create additional cognitive load. If materials are redesigned to reduce the amount of split attention, then cognitive load is reduced and this makes the task of mental integration easier. The genre templates used in the current study will have a positive impact upon the cognitive load experienced by the learners and this may relate to the way in which they are used. In particular, learners
may have preferences for tools that help them to reduce cognitive load as they process information. Also tools that learners prefer to use may relate to differences in the way learners process information and approach learning tasks. The genre templates may provide cognitive support for problem solving, the development of other higher order cognitive skills and cognitive overload.

Multimedia learning environments can be designed to cater for various learning styles, but a considerable amount of judgement is needed by the instructional designer. If the environment is too organised and only suits a particular learning style, then the individual who approaches the material from another perspective may be frustrated when they try to assimilate the materials into their cognitive structure (Hammond & Allinson, 1991; Jonasssen, 1988; Underwood, 1988; Tripp & Roby, 1990). Also if the learning environment is unstructured, then cognitive load associated with navigation will reduce its effectiveness. More research is needed with reference to cognitive styles to solve these issues.

Learning styles/approaches

An established history of research suggests that learning styles influence the ways in which learners process information (Dunn et al., 1982; Kolb, 1984; Claxton & Hurrell, 1987; De Bello. 1990; Dunn et al., 1989; Jung, W., 1993; Jonassen & Grabowiski 1993; Schmeck. 1988; Sims & Sims, 1995). Since most learners have preferred ways of learning, researchers claim that different cognitive (learning) styles require different modes of learning (Romiszowski, 1990; Tyler, 1993; Allinson & Hammond, 1990; Stanton & Baber, 1992; Jonassen & Grabowiski, 1993). Similarly, Mesick describes cognitive styles as characteristic self consistencies in information processing.
that develop in congenial ways around underlying personality trends (Messick, 1984, p. 23). For the purposes of the current study the terms learning style and cognitive style are interchangeable.

While various systems of learning styles have been proposed, there are three popular categories. Curry's (1987) extensive study of 21 learning style instruments from North America, Europe and Australia suggested that it is possible to reorganise these instruments into a tree like layer system of categories based upon various learner preferences (Curry, 1987). These can be arranged in layers like an onion. The outer layer is based upon instructional and environmental preferences, the middle is based upon information processing preferences and the inner layer is based upon personality-related preferences. Because the current study focuses upon the processing of information, only the categories that focus upon information processing are discussed.
Table 2.2: Summarises the learning style inventories based upon information processing preferences (Curry, 1997 cited by Ferry, 1997, p. 74).

<table>
<thead>
<tr>
<th>Learning Style</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schmeck</td>
<td>Highest rated based on reliability and validity. Not chosen due to length and lack of references.</td>
</tr>
<tr>
<td>Biggs</td>
<td>Adopted for use during the study and discussed in chapter three.</td>
</tr>
</tbody>
</table>

The inventories in Table 2.2 are based upon information processing preferences and relate to an individual's cognitive approach to the assimilation of information. Of the 7 inventories mentioned the highest rated (based upon reliability and validity) was given to Schmeck and this was followed by Biggs. Biggs's learning theory was adopted for use during the current study and is discussed in more detail in chapter three as a framework for data collection. Schmeck's inventory was not chosen as it was a longer inventory to fill out by participants. It was not as well referenced or presented.
when reviewing the literature methodology in educational technology when compared to Biggs's inventory.

Broadly speaking, the theory underpinning the measurement of learning styles is that students' learning processes are biologically determined learning preferences in respect of environmental, emotional, sociological, physical and psychological conditions (Price, Dunn, & Dunn, 1991). Varying preferences for each of these learning conditions combine to provide an individual learning style profile. In addition, since preferences are largely biologically determined, a learner's learning style will necessarily be resistant to change, implying that instruction needs to take account of learning styles rather than trying to change them (Murray & Harvey, 1994).

In stark contrast to this conceptualisation, Biggs (1987a, 1987b) suggests that the process of learning is determined by students' approaches to learning, which is a composite of students' motives and strategies to learn as well as their perceptions of tasks. Importantly, different approaches to learning are open to change and development, according to changes in motives, strategies and task perception (Biggs, 1987a, 1987b). Furthermore, it is contended that deep achieving approaches to learning are more likely to result in better learning outcomes and consequently, instruction should be provided to encourage students to develop these approaches to learning. Learning approaches represent student learning processes which appear to influence achievement (Harvey, 1994). Learning approaches represent the conceptualisations that provide a framework for understanding how students learn and why there are differences between students learning, therefore these
approaches need to be addressed in terms of learning outcomes for the current study.

Biggs (1987) suggested that learning approaches lead to different kinds of learning outcomes. The surface approach leads to retention of factual detail at the expense of the structural relationships inherent in the data to be learned, while emotional or affective outcomes are feelings of dissatisfaction, boredom or outright dislike. The deep approach leads to an understanding of the structural complexity of the task and to positive feelings about it. The achieving approach, particularly in combination with deep learners, leads to good performance in examinations, a good academic self concept and to feeling of satisfaction. In the long term Biggs found that those students who predominantly use deep and or achieving approaches say they intend to continue beyond their first degree, to Honours or a higher degree of some kind. The composite deep achieving approach is associated with the attributes of formal education.

Learning approaches, especially deep and achieving, are most effective when students are consciously aware of their own learning processes and try deliberately to control them. In this important process called metalearning, students adopt those strategies that are congruent with their motives: if they are curious (deep motive) they will want to find out and understand all that they can about it (deep strategy); if they want to achieve top marks (achieving motive) they will organise their approach accordingly, study according to a schedule, hand assignments in on time, for example (achieving strategy) (Biggs, 1987).

The student's approach to learning is a composite of a motive and an appropriate strategy (Biggs, 1987a). For instance, students who
are (1) intrinsically motivated tend to extract most meaning from their learning; they read widely, relating new content to what they already know. Students who are learning in order to get by with (2) minimal trouble, or simply to pass their subjects without aiming high, are likely to focus on the essentials and rote learn them. In listing these two scenarios, Biggs has described these as deep, achieving and surface approaches to learning. The LPQ operationalised these approaches and their constituent motives and strategies in terms of profiles. The profiles represent an individual’s general orientation to learning.

Surface and deep strategies describe ways in which students engage the actual task itself, while the achieving strategy describes the ways in which students organise the temporal and spatial contexts in which the task is carried out. It is therefore possible for students to combine an achieving approach with either a surface or a deep approach. That is, a student may see the way to obtain top marks as consisting of selectively rote learning in an organised and systematic way or more usually reading widely and seeking meaning in an organised and systemic way. The latter composite approach called deep achieving is quite powerful and is characteristic of many successful students (Biggs, 1987a, 1987b). The implications for this study are to understand what types of strategies and motives students are engaging in with the actual task itself, while using or not using the template to produce a learning outcome.

Understanding of learning approaches to date has largely been associated with learning in an institutionalised context with an instructivist epistemology in mind. What needs to be demonstrated from a research perspective is how students within a constructivist
framework cope with and use their approaches to learning together with embedded electronic resources and sophisticated cognitive tools. One way of doing this is to assess the extent to which students endorse the more important approaches to learning and the motives and strategies comprising these approaches (Biggs, 1987a, 1987b). The learning process questionnaire (LPQ) operationalises these approaches and their constituent motives and strategies in terms of profiles. The profiles represent an individual’s general orientation to learning. Learners with poor metacognitive skills may or may not be supported by the use of genre templates in an interactive multimedia learning environment when compared to using the genre templates in a traditional learning environment.

A different perspective on learner preferences for certain types of information was taken by Bowen (1992). This study examined the way learners accessed relevant information chosen to assist them to solve problems. It examined the strategies adopted by learners when they could access hints to help them solve problems. The findings showed that learners adopted one of the following five strategies:

- some were determined to solve the problem without resorting to hints;
- others requested a hint after giving the challenge a good try;
- another group of learners pursued a hint only far enough to get the an idea and then proceeded with the challenge (that is students exited the hints early);
- others went freely to the hints as if they were tutorials to be completed before attempting the challenge and
- finally a few students examined the hints after completing the task to see what suggestions were made.
Bowen claimed that the final strategy could be valuable as it helped students to formalise and generalise the techniques they employed. Bowen recommended that students could be shown a variety of learning strategies that gave the learner skills to tackle a challenge with vigour if it appealed to them. These students were more likely to use trial and error, but they were students who were not the highest achievers.

Recent research has shown a strong link between an individual's cognitive style and her/his reactions to computer-assisted instruction or computers in general. According to Moldafsky and Kwon (1994), research indicates that cognitive style can be responsible for an individual's skill in information processing, decision making attitudes towards computers and computer anxiety. In 1994, Hsu, Frederich and Chung found that individuals with particular cognitive styles significantly outperformed others in the recall of the content of computer based instruction. Rowland and Stuessy (1988) have reported on an example of a study which matched alternative modes of CAI to cognitive style. They found that cognitive style, in this case whether holist and serialist, interacted with various modes of CAI to influence student achievement. Burger (1985) further supports this notion. Her research is another example of a study which investigated the interaction of cognitive style (field independence/field dependence) and preference for academic achievement in computer assisted instruction. The current research study will examine whether learners with one particular cognitive style significantly outperform others when using genre templates in an interactive multimedia learning environment.
In early research Witkin et al., (1977) found that individuals with field independent cognitive styles were able to precisely identify the critical information contained in a complex visual environment. Field dependents on the other hand, generally do not mentally restructure a visual presentation. Field dependants, accept and interact with information the way it is presented (Witkin, 1977; Dwyer & Moore, 1992). These facts have strong implications for intelligence gathering, information processing and the critical analysis of visual information. Flannery (1993), found that field dependents process information in a simultaneous manner. Ideas are seen all at once rather than in some observable order. If information is not connected to something the individual values, it is discarded. Field independents use logical, inductive information processing. They perceive information objectively. Information for field independents does not have to be concrete or personalised (Somonson, Hays & Hall, 1996, p. 784).

The above authors stress that future studies should look at the development of a test environment which mimics the real world to see how individuals approach problem solving and decision making. We should track such items as cognitive strategy and time on task, which could identify ability to perform in stressful situations (p. 796). The current study provides one such environment, tracking students’ cognitive styles through learner use of their PDA’s (Personal digital assistant) as electronic information storage spaces that can also contain the genre templates. The Group Embedded Figures Test (Willard, 1985 & Witkin, Oltman, Raskin & Karp, 1971). The implications for the current study have been to establish if there was a relationship between FD and FI learners with the use or non-use of the genre template. If it helps one particular group and not the other then the researcher and designers of educational
software packages need to consider how and why this helped a particular group. This in turn may affect the further development of future learning environments to support all types of learners.

Another factor that will affect the development of future interactive learning environments, besides how learners approach a task, process information, solve the problem and produce an outcome, is the assessment of that task or learning outcome.

Assessment

At the micro level, tests are used to direct student attention to certain topics, to diagnose student learning difficulties and provide support accordingly and to report student progress to students, teachers and parents (Collins, 1990). However, there is a growing consensus that traditional methods such as standardised testing, criterion referenced tests and teacher constructed tests fail to measure important learning outcomes (Shepard, 1989). Such tests focus heavily on recall of declarative and procedural knowledge and provide little to indicate the level at which a student understands or the quality of individual thinking (Nickerson, 1989; Slack, 1993). Given the nature of situated learning the selection of appropriate assessment measures and methods is especially relevant. The current study has based the assessment process on performance assessment.

Performance assessment requires learners to demonstrate their capabilities directly by creating some product or engaging in some activity (Haertel, 1992). Wiggins (1993) and others promote performance assessment over traditional assessment because performance assessment is focused on students' ability to apply knowledge in ill-defined ambiguous contexts that demand
judgment. Proponents of performance assessment assert that traditional testing largely measures inert knowledge that may or may not be cued by a few artificial stimuli. Linn, Barker and Dunbar (1991) list the following key attributes of performance assessment:

- it focuses on complex learning;
- engages higher order thinking and problem solving skills;
- stimulates a wide range of active responses;
- involves challenging tasks that require multiple steps and
- requires significant commitments of student time and effort.

Performance assessment does not focus on interim drafts that learners produce during performance as does portfolio assessment. Although performance assessment is somewhat novel in classroom contexts, it has long been a highly valued assessment strategy in the performing arts. Finch (1991) provides guidance to developing, implementing, scoring and reporting performance assessments. Performance tests take many forms, ranging from simple written tests to complex simulators. In the former case, asking a student to write a brief essay in reaction to a poem would be considered a performance test (Wilson, 1996, p. 194).

Focusing on higher order outcomes requires an emphasis on alternative approaches to assessment (Mitchell, 1992; Reeves & Okey, 1996). Higher order learning outcomes such as the ability to frame and resolve ill-defined problems or the tendency to exhibit intellectual curiosity are rarely directly observable. These types of outcomes can only be inferred from students' performance on a range of alternative assessments (Neimeyer, 1993). Alternative cognitive assessments are likely to be quite different from
traditional testing procedures that assess lower level knowledge and skills. Research focused on the higher order outcomes of cognitive tools such as hypermedia/multimedia construction software must proceed hand in hand with the development of reliable, valid, and feasible cognitive assessments (Worthen, 1993). Cognitive assessment focuses on the higher order thinking skills possessed by learners as well as the metacognitive skills learners employ during learning (Merluzzi, 1986). Metacognition refers to the mental processes we use to monitor and regulate our own learning (Flavel, 1976). What problem solving and metacognitive skills mean in a virtual learning environment is still unknown. Assessment in every case is individualised, collaborative, continuous and multifaceted, with attention to both the process and products of learning.

Assessment is being used to shape and direct future learning. In helping students to a conscious knowledge of what they know, understand and can do, it is developing metacognition, which is identified as a key component in successful learning. Metacognitive thinkers are aware of the strategies available to them and are able to select the best for a particular situation, behaving thereby as deep learners. Surface learning is more characteristic of learners who plough into problems without thinking about the material; they behave as though the goal were to reproduce what they have noted, to duplicate, not to create understanding.

Problems and issues

The content of tests influences, explicitly and implicitly, teaching and learning processes. Teachers often teach to the test rather than emphasising underlying concepts. Skills are taught in the manner measured on tests rather than how they are used in everyday
contexts. When tests require the recall of memorised information, students develop memorisation strategies that tend to decontextualise their knowledge, promoting compliant cognition (McCaslin & Good, 1992). As a consequence, traditional testing strategies are often counter-productive for the solving of real world problems (Collins, 1990).

The second problem with traditional testing is that it tends to emphasise worth or merit of one's effort according to external criteria. Students are judged as having learned or not learned relative to such criteria. The purpose is not to promote individual cognitive growth, but to determine the external importance of such growth. In traditional tests, the criteria for acceptability are based on the instructional goals or objectives of teachers, curricula or administrators: the testing is separated from the learning process.

Both traditional and contemporary approaches to assessment play important roles in performance. However, assessment methods tend to underestimate growth in cognitive and learning processes and decontextualise assessment from authentic situations. Since a primary goal of education is to promote students' thoughtfulness, the basic concept of testing needs to change, not just the structure of the tests (Brown, 1989).

In order to become capable, learners need experience in solving real problems and understanding complex tasks. Assessment, therefore, needs to approximate real life tasks more closely and invoke more complex and challenging mental processes: assessment standards need to reflect multiple perspectives and diversity versus singularity of problem solutions (Shepard, 1989). Several trends have emerged as reviewed by Jonassen (1996). These include self referencing, flexible transferable knowledge and skills,
diversity and flexibility of learner centred measures, generating and constructing, continuous ongoing process, ecological validity and multiple assessment.

COGNITIVE TOOLS

Cognitive tools are based on the assumption best articulated by Scadamalia et al. (1989): it is not the computer that should be doing the diagnosing, the goal setting and the planning; it is the student (p. 54). Learners need to know how to monitor and regulate their own learning processes when solving problems within an interactive multimedia learning context. Metacognition helps learners develop cognitive processes that analyse and manage their own thinking in pursuit of knowledge acquisition in order to solve problems, gain insight and become critical thinkers. An example of a cognitive tool is a genre template (Harper et al., 1996). Cognitive tools in the form of genre templates for writing can provide further support for the process of learning. In an interactive, multimedia, student centred learning environment, genre templates as cognitive tools can help remind students of their metacognitive strategies together with the facilitation of a variety of cognitive tools and resources. Cognitive tools are evaluated for the kinds of cognitive activities they stimulate and the kinds of abilities (even domain specific) which they foster (Lajoie, 1993, p. 181). If students know how to monitor their cognitive processes and regulate their learning to solve problems they will then be better able to select appropriate metacognitive strategies to facilitate their own problem solving skills.

Salomon, Perkins, and Globerson (1991) make an important distinction between the effects of learning with and of technology:
First, they distinguish between two kinds of cognitive effects: effects with technology obtained during intellectual partnership and the effects of it in terms of the transferable cognitive residue that this partnership leaves behind in the form of better mastery of skills and strategies (p. 2). If used in the current study with technology would refer to the intellectual partnership gained between the student and the use or non-use of the genre templates as a scaffold and strategy in helping the learner to synthesise a written response to a given task. On the other hand, if the of technology were used it would refer to the transferable cognitive residue that this partnership between the student and the use or non-use of the genre templates as a scaffold leaves behind in the form of better mastery of metacognitive skills and strategies.

Cognitive tools are important in both respects. With respect to the with effects, this researcher agrees with Salomon et al., (1991) that the cognitive effects with computer tools greatly depend on the mindful engagement of learners in the tasks afforded by these tools (p. 2). The author of the current research study agrees with Jonassen and Reeves (1996) in that educators should empower learners with cognitive tools and assess their abilities in conjunction with the use of these tools. This issue is what the current study is trying to emphasise: empowering learners with embedded electronic genre templates together with other cognitive resources in an information landscape and assessing their use or non-use of the genre templates with student learning processes and outcomes. In addition, data collected from the current study may help us in empowering learners with poor metacognitive strategies and assess their use of these strategies in conjunction with their learning approaches and outcomes.
Salomon et al., (1989) concluded that a computer tool that provides metacognitive guidance may motivate the learner to expend voluntary effort to learn. They suggested the prospect that the computer be considered an intellectual partner in this endeavour. Most importantly, the researchers implied that student interaction with a computerised tool, capable of activating the thinking processes and providing metacognitive guidance, could transfer to other activities. Even though the researchers failed to evaluate the program they utilised, their investigation appeared to confirm the belief that new problem solving tools such as the computer should be utilised to help students develop metacognition.

On the other hand, Jones and Winne (1995) suggested that a well designed reflection/constructivist tool may help students develop higher metacognitive awareness and knowledge, but unless conditions for transfer are met during learning, newly acquired metacognitive abilities are not likely to be carried outside the immediate instructional environment. To facilitate transfer of newly acquired cognitive skills, Pressley et al (1984) argued for the use of informed training procedures. The current study is not identifying transfer skills with cognitive tools used within different contexts. Moreover, it is identifying students' use of the cognitive tool and approaches to learning with and without the cognitive tool, during the learning process within a constructivist learning environment using multimedia.

Student use of the genre template together with other embedded cognitive tools may entail a new conception of ability as an intellectual partnership between the learner's mind and various cognitive tools. Although some might worry that this partnership makes learners too dependent upon the technology to perform
without it, we must recognise that many contemporary performances are meaningless without the technologies which enable them. Allowing students to demonstrate their learning in collaboration with cognitive tools may be attacked by certain authorities with heavy investments in the existing system, but we should remember that such attacks have occurred in the face of every innovation. For example, Plato (cited by Salomon et al., 1991), criticised written language as a technology that would weaken human memory. Just as one would not assess the ability of an artist without allowing the use of brushes, paint, and other media, one should not assess contemporary intellectual abilities without the tools of contemporary intellectual practices, including books and computers (Salomon et al., 1991). Indeed, our very conception of knowledge must change. For example, Simon (1987) maintains that we should move from a conception of knowledge as possession of facts and figures to one of knowledge as the ability to retrieve information from databases and use it to solve problems. Salomon et al., (1991) argue that existing research, largely experimental, 

...has demonstrated more what transferable effects the partnership with computer tools and programs can be made to have than the effects it actually does have under more natural conditions of daily employment (p. 6-7).

The current study concentrates on what effects the genre templates may have on different types of learners. The genre templates are used on a daily basis employed within a school-based setting.

One of the false promises of many previous instructional innovations has been to make learning fun and easy (Cuban, 1986). Cognitive tools make no such promise, either for learners or teachers. Instead, cognitive tools and interactive learning
environments activate complex cognitive learning strategies and critical thinking. These computer-based tools not only extend the mind, they have the potential to reorganise mental functioning (Pea, 1985) and engage learners in high level generative processing of information (Wittrock, 1974). In generative processing, deeper information processing results from activating appropriate mental models, using them to interpret new information, assimilating new information back into those models, reorganising the models in light of the newly interpreted information, and using the newly extended mental models to explain, interpret, or infer new knowledge (Norman, 1983). Knowledge acquisition and integration, according to these perspectives, is a constructive process involving mindful cognitive effort (Langer, 1989; Salomon & Globerson, 1987). When using cognitive tools, learners engage in knowledge construction rather than knowledge reproduction.

Cognitive tools actively engage learners in creating knowledge that reflects their comprehension and conceptualisation of information and ideas rather than absorbing predetermined presentations of objective knowledge. Cognitive tools are learner-controlled, not teacher-controlled or technology-driven. For example, when students construct databases, they are constructing their own conceptualisation of the organisation of the content domain. Cognitive tools are not designed to reduce information processing, to make a task easier, as has been the goal of instructional design as a field and many previous instructional innovations. Nor are they fingertip tools (Perkins, 1993) that learners use naturally, effortlessly, and effectively. Rather, cognitive tools are essential components of a learning environment in which learners are required to think harder about the subject matter domain being
studied or the task being undertaken and to generate thoughts that would be impossible without these tools (Jonassen, 1996).

As noted above, cognitive tools are reflection tools that amplify, extend, and even reorganise human mental powers to help learners construct their own realities and complete challenging tasks. However, the enormous potential of cognitive tools can only be realised within a constructivist framework for learning. Moreover, the nature and source of the task becomes paramount in such an environment. Past failures of tool approaches to using computers in education can be largely attributed to the relegation of the tools to traditional academic tasks set by teachers or the curriculum within the context of outmoded instructivist pedagogy. Cognitive tools are best used by students to represent knowledge and solve problems within the context of pursuing investigations that are relevant to their own lives. Those investigations are ideally elicited or supported by a constructivist learning environment (Duffy & Jonassen, 1993). Cognitive tools are less likely to be effective when used to support only teacher-controlled or curriculum-driven tasks.

Why cognitive tools?

The history of educational communications and technology includes numerous examples of failed innovations and unfulfilled promises. Cognitive tools could become yet another casualty in the difficult struggle to improve teaching and learning unless it has a strong foundation of theory and practical principles to support it. Jonassen (1996) suggests that constructivism and its attendant principles constitute a strong rationale for using technology as cognitive tools (p. 7).
Cognitive tools can help us as learners organise, restructure, and represent what we know (Jonassen, 1996, p. 8).

Cognitive tools and the goals, tasks, culture, resources, and human collaboration integral to their use enable learners to engage in active, mindful, and purposeful interpretation and reflection. In traditional instruction, active refers to stimulus, response, feedback, and reinforcement conditions that help students mirror accepted views of reality whereas in constructivist learning environments, active learners participate and interact with the surrounding environment to create their own interpretations of reality (p. 9).

Learning with technologies amplifies the learner's cognitive processes while using those technologies. Rather than developing ever more powerful teaching hardware, we should be teaching learners how to think more effectively with the use of technology tools. Flavell et al (1977) state that environments should provide a mechanism for monitoring knowledge. This entails metacognitive awareness of this knowledge, which is the highest order of intellectual processing. Jonassen suggests (1992) that we should focus less on developing sophisticated multimedia delivery technologies and more on thinking technologies, those that engage thinking processes in the mind. Recent research shows that learners develop critical thinking skills as authors, designers and constructors of knowledge and learn more in the process than they do as the recipients of knowledge prepackaged in educational communications. Learning with technologies presents a major challenge for researchers in our field (Jonassen, 1996).

Jonassen in his work on mindtools (1996) reviewed the constructive roles learners may take and refers to mindful learning and self regulated learners. He states that Salomon and Globerson (1987) suggest three reasons as to why learners often are unable to think,
to learn, to solve problems and to reach their learning potential. Firstly learners have not acquired a repertoire of learning strategies for successfully accomplishing different kinds of learning tasks. Too often they apply a brute force memorisation strategy and when that does not work they lack alternative strategies to employ.

Secondly, learners are poorly motivated. Jonassen believed that the most pandemic, yet most insidious cause for underachievement in schools is lower expectations on the part of teachers, which reduces expectations of students and parents, which further erodes the expectations of teachers within the entire educational system. Salomon and Globerson (1987) also refer to factors such as learned helplessness, poor perceived self efficacy and improper attribution of success or failure.

Thirdly students tend to rely on vague perceptions and global, quick fix solutions to problems rather than thinking about and analysing them that is engaging in effortful reasoning. When students are not motivated to perform, their initial strategy is to misapply their misconceptions rather than break down the problem, analyse assumptions, elaborate on the information, synthesise a response and use other critical thinking skills.

Research to date shows us that students who have received metacognitive instruction perform better than those who do not within a computer learning environment (Houseman, 1991; Stevens, 1992). Research also shows us that Multimedia/Hypermedia as cognitive tools support learners when using problem-based learning environments (Jonassen, 1995; Brown, 1994 and Lehrer, 1993). Cognitive tools do not contain preconceived intelligence in the sense that intelligent tutoring systems are claimed to possess, but they do
enable intellectual partnerships in the form of distributed cognitive processing (Jonassen, 1996).

The effectiveness of any tool is dependent on the user and the task (s)he faces. With cognitive tools, the method of representation has to fit the learner’s abilities, learning styles and preferences (Kommers, 1993). As with all tools, cognitive tools have limited applicability and require training. Within these limitations, educators have some say in determining the pedagogical and contextual elements of our cognitive structures and cognitive tools may be used for stimulating thinking and not for transferring representations to the learners. This is where the genre templates in the current study can be used to provide scaffolds and hints to students with poor metacognitive strategies. Students can choose to assimilate the prescribed example of the genre template or manipulate it into their own conceptual schemata. They do not even have to start with it. They can cut and paste sections of it or choose to use it at a time convenient to them while completing a task in an interactive multimedia software program.

Jonassen and Reeves (1996), through their continued research into learning technologies and the use of authoring environments as cognitive tools, found that students needed to develop major thinking skills to use as designers of learning (Carver, Lehrer, Connell & Erickson, 1992). These included project management skills, research skills, organisation and representation skills, presentation skills and reflection skills. The organisational and representational skills are of particular interest because they concentrate on deciding how to segment and sequence information to make it understandable. Deciding how information will be represented (text, pictures, movies, audio, etc) and deciding how the
information will be organised (hierarchy, sequence) and how it will be linked are higher order thinking skills.

A study that relates very closely to the one that the author has undertaken is titled Adventureplayer (cited by Pea, 1995): A microworld anchored in a macrocontext (Intelligent learning environment, educational software). A primary goal of the Adventureplayer research has been the development of an architecture for computer-based learning environments that combines the benefits of intelligent tutoring systems developed by cognitive scientists and education researchers. Adventureplayer effectively integrates a number of beneficial components. The template-based planning notebook used in this study allows students to communicate and represent planning actions. Using the notebook, students are able to develop plans in a non-linear sequence and planning actions may be specified in an abstract manner. The results of this study suggest that timeline, simulation and coaching components provide significant benefits to the overall system. This study was of interest to this researcher because it identified a template-based planning notebook which the CD-ROM package *Exploring the Nardoo* also has and may be used by students in conjunction with the genre templates.

They are tools inasmuch as their operation depends on the learner's operations; they are cognitive inasmuch as they serve to aid students in their thinking, allowing them to transcend their cognitive limitations and engage in cognitive operations they would not have been capable of otherwise (Pea, 1995, p. 15).

Cognitive tools are evaluated for the kinds of cognitive activities they stimulate and the kinds of abilities (even if domain specific) which they foster (Salomon 1991, p. 181).
Salomon (1993), claims that intellectual partnership with computer tools should not aim at improved performance through the distribution of cognitions as its ultimate goal. Rather, the partnership ought to be designed such that it leaves the individuals with solo cognitive residues (e.g., improved skill mastery) that would improve students' autonomous higher thinking skills as well as affect their subsequent partnerships with the tool. Thus seen in an education context, tools ought to be pedagogic rather than just performance oriented: They should be designed in a way that turns effects with them into more lasting effects of them (p. 184). One study that was designed with these considerations in mind was called the Writing Partner by Zellermayer, Salomon, Gilberson and Givon (1991).

The study by Zellermayer, Salomon, Gilberson and Givon (1991) related metacognitions through a computerised writing partner to enhance writing. The main purpose of the study was to test the general hypothesis that ongoing computerised procedural facilitation with strategies and writing-related metacognitions during writing improves learners' writing while the learners were being helped. This ongoing facilitation was thought to leave a cognitive residue in the form of subsequently improved writing once that help was removed. Three groups of 20 ninth to eleventh graders participated in the study. One group wrote five essays while being guided by unsolicited continuous metacognitive-like guides presented by a specially designed computer tool (the Writing Partner); the second group received the same guidance but only upon the writer's voluntary solicitation; and the third group received no guidance and wrote with only a word processor (control group).
The study's main hypothesis was confirmed with respect to the unsolicited guidance group which wrote better training essays, showed evidence of having internalised the explicitly provided guidance and demonstrated significant subsequent improvement in writing when no computerised tool was subsequently available. The solicited guidance group and the control group showed virtually no improvement, and unlike the unsolicited guidance group, initially poorer writers continued to lag behind initially better writers (p. 373).

The study of Zellermayer et al (1991) is similar to the current study in that the genre templates as scaffolds that provide hints to the learner could also be referred to as related metacognitions through a computerised writing partner to enhance writing. However the Zellermayer et al (1991) study was not administered using a constructivist approach or other embedded cognitive tools and interactive multimedia resources.

*Shaping the study: the factors*

*Computers as tools to develop metacognition*

Cognitive tools should be readily accessible to learners to support reflective thinking on what they have learned and how they have come to know it, supporting internal negotiation of meaning-making and constructing personal representations of meaning-making within the context of learning.

Cognitive tools provide an environment and vehicle that often require learners to think harder about the subject matter domain being studied while generating thoughts that would be difficult without the tool (Jonassen, 1996, p. 12).
Jonassen (1996) has reviewed technology as a tool for accessing information, representing ideas, communicating with others and generating products. Cognitive tools help the learner by supporting students' constructive processes, as well as the results of those cognitive processes. A wider variety of research using cognitive tools, possibly in the form of genre templates, may be further defined with respect to students' learning processes.

One of the constructivist principles stated earlier in this literature review with regard to the implementation of cognitive tools is: Ideally, tasks or problems for the application of cognitive tools should be situated in realistic contexts with results that are personally meaningful for learners. Beichner (1994) reports on a project where these conditions were met in a unique way. The subjects in this study were seventh and eighth grade students enrolled in a middle school located on the grounds of a large, metropolitan zoo. The school is a magnet school emphasizing the study of science to which students are admitted based upon a lottery. A primarily qualitative, observational investigation was conducted over a two-year period while the students worked cooperatively to create interactive displays for a touch-sensitive multimedia kiosk for the zoo.

Several categories emerged out of the qualitative analysis of the data which included extensive videotapes, interviews, observations, and student-created materials. The students' strong appreciation that they were preparing multimedia materials for a real audience emerged as the core category in the analysis. Additional positive findings were: (1) students demonstrated great concern for accuracy in their displays (2) students quickly assumed the major responsibility for content and editing decisions despite the fact that
the original task of designing the displays had been structured for them by the teacher (3) students accessed wide ranges of science materials and sources to find the content they desired and (4) their commitment to and enthusiasm for the project remained very high. On the negative side, the project failed to integrate its activities into the larger curriculum in the school or to attract the participation of teachers other than the computer coordinator. The bottom line was that by establishing an environment where creative thinking about content is combined with real-world assignments, students learned the content, enjoyed the learning process, and recognised that they had created something worthwhile. Unlike the study by Beichner (1994), the current study did incorporate the research project into the larger curriculum by including the task that was generated from within the software program and used as part of the students' science assessment task.

The students' commitment to and enthusiasm for the assessment task remained very high and as this was a selective high school, competition was very high amongst the students. The software program Exploring the Nardoo was linked closely to the curriculum, it contained the learning specified in the national curriculum for high school children.

Another study by Lehrer (1993) describes the development, use, and results of a hypermedia construction tool called HyperAuthor that was used by eighth graders to design their own lessons about the American Civil War. This study exemplifies the principle that: Cognitive tools empower learners to design their own representations of knowledge rather than absorbing knowledge representations preconceived by others. As Perkins (1986) maintains, knowledge is a process of design and not something to be
transmitted from teacher to student. Thus, students should be engaged in HyperComposition by designing their own hypermedia (Lehrer, 1993). The process requires learners to transform information into dimensional representations, determine what is important and what is not, segment information into nodes, link the information segments by semantic relationships, and decide how to represent ideas. This is a highly motivating process because authorship results in ownership of the ideas in the presentation. This raises the issue then for the current study of what does the manipulation and organisation of the genre templates as cognitive tools imply for the learning situation, especially when incorporating interactive multimedia.

Students in the Lehrer (1993) study were high and low ability eighth graders who worked at the hypermedia construction tasks for one class period of 45 minutes each day over a period of several months. The students worked in a media centre of the school’s library where they had access to a colour Macintosh computer, scanner, sound digitiser, HyperAuthor software, and numerous print and non-print resources about the Civil War. An instructor was also available to coach students in the conceptualisation, design, and production of the hypermedia programs. Students created programs reflecting their unique interests and individual differences. For example, they created hypermedia about the role of women in the Civil War, the perspectives of slaves toward the war, and not-so-famous people from that period.

According to Lehrer (1993): The most striking finding was the degree of student involvement and engagement (p. 209). Both high and low ability students became very task-oriented, increasingly so as they gained more autonomy and confidence with the cognitive
tools. At the end of the study, students in the hypermedia group and a control group of students who had studied the Civil War via traditional classroom methods during the same period of time, were given an identical teacher-constructed test of knowledge. No significant test differences were found. Lehrer conjectured that these measures were not valid indicators of the extent of learning in the hypermedia design groups, perhaps because much of what students developed in the design context was not anticipated by the classroom teacher (p. 218). However, a year later, when students in the design and control groups were interviewed by an independent interviewer unconnected with the previous year's work, important differences were found. Students in the control group could recall almost nothing about the historical content, whereas students in the design group displayed elaborate concepts and ideas that they had extended to other areas of history. Most importantly, although students in the control group defined history as the record of the facts of the past, students in the design class defined history as a process of interpreting the past from different perspectives. In short, the hypermedia design approach led to knowledge that was richer, better connected, and more applicable to subsequent learning and events (p. 221). The current study argues that using the genre templates is also a design process for gathering, organising and monitoring information gathering and knowledge construction for learners who do not have these skills already.

Lehrer, Erickson, Love, and Connell (1994) conducted another study with ninth grade students who were using HyperAuthor to develop hypermedia about World War I, lifestyles between 1870 and 1920, immigration, and imperialism. They found similar results to the aforementioned Civil War project: (1) students' on-task behaviour increased over time (2) students perceived the benefits of planning
and transforming stages of development: and (3) they developed generalisable skills such as taking notes, finding information, coordinating their work with other team members, writing interpretations, and designing presentations. The current study argues that, as for Lehrer, the genre templates should empower learners to design their own representations of knowledge rather than absorbing knowledge representations preconceived by others. Some may argue that the genre templates are a preconceived structure for the writing process in the form of a scaffold. The current study does not dispute this: the research focus is more concerned with how students are coping with a variety of technology-embedded resources. What is of interest for the current study is that students in the Lehrer study developed generalisable skills such as taking notes, finding information and writing interpretation. If we give students a starting point in the form of a scaffold can we achieve the same outcomes?

The Highly Interactive Computing Environments (HI-CE) Group at the University of Michigan had developed a multimedia composition tool called MediaText (Hays, Weingard, Guzdial, Jackson, Boyle, & Soloway, 1993). They believe that rather than using media to deliver instruction to learners, learners should use the media to generate their own instruction, and in so doing, learn more about the content. The HI-CE group has studied high school students creating MediaText stories, biographies, or instructional aids, as well as multimedia essays. Students have learned to use techniques such as mentioning, directives, titling, and juxtaposition to integrate their documents. The HI-CE group found that as students’ experiences with MediaText increase, their documents become more integrated rather than merely annotated text. This raises the issue of whether all students who produce a written response integrating multimedia
believe that they are learning more because they understand the ideas better.

The ACCESS (American Culture in Context: Enrichment for Secondary Schools) Project (Spoehr, 1994; Spoehr & Shapiro, 1991) focuses on the subject-matter commonly taught in high school, such as United States History, American Literature, and American Studies. The project began with teachers assembling a collection of textual, pictorial, audio, and video materials to supplement their courses. Initially, students simply used the materials for information retrieval. Students who made more extensive use of the conceptual organisation built into the system benefited more than the students who used the system like a linear electronic book. The researchers found that hypermedia’s effectiveness depends on the extent to which students can internalise the important conceptual structures in a subject matter as they browse. The current study furthers Access findings of ‘hypermedia effectiveness’ with students by identifying what types of students internalise genre templates as conceptual structures.

THE CURRENT STUDY: SPECIFIC ISSUES

The current study sought to explore the ways in which students employed aids to support her/his problem-solving. The current study incorporates further exploration of learners’ experiences and self organisation by introducing genre templates as scaffolds. One aim of the genre templates is to help learners start with their experiences and identifying self organisation not only as a product but as a process when assimilating and accommodating new
knowledge, while gathering information that is presented in multiple modes.

From Ausubel, the current study reviews the issue of scaffolding and cognitive structure. Observing at what stage learners use or do not use scaffolds to restructure knowledge and acquire new information, while adapting their own concepts and experiences, may be one way of providing an insight into a learner's cognitive structure. In the current study the monitoring and collection of information regarding students' cognitive structure has been identified by the collection and analysis of data in relation to students' process notes and a post treatment student questionnaire.

What the review of literature suggests in relation to theories of learning and in particular constructivism, is that there is a difference in how students use the processes of; self management and learning from a constructivist epistemology as opposed to an instructivist epistemology. Norman (1993) argues that,

... computers support reflective thinking when they enable users to compose new knowledge by adding new representations, modifying old ones and comparing the two (p. 11).

If we now move on to a newer generation of resources in the form of tools, greater advantages for learning may be identified. One particular program that has already incorporated constructivist ideas, principles and values used is the current study with new technology tools is the software package Exploring the Nardoo. It is apparent that we need to focus efforts on the development of tools and environments that support communication and collaboration among learners and experts (Tripp, 1993).
The genre templates provide cognitive support for problem solving by establishing a framework for student presentation which will concentrate thought, facilitate investigation and the development of critical and creative thinking. It incorporates problems that challenge students to become active participants in the learning process. The CD-ROM *Exploring the Nardoo* provides the student with a flexible set of tools, made available through a personal digital assistant, for the investigation process. The package also enables the user to record thoughts and impressions on the fly whilst examining media stories. It has the potential to help students reorganise or revise their thoughts to better make sense of what they see and hear. Students are able to document their emerging ideas in support of an investigation or problem solving exercise whilst viewing different media. It is to help students match their learning processes with that of a genre template while at the same time organising information and the reconstruction of new knowledge at a time appropriate to the student. One way of organising thoughts that are presented as information represented in multiple media is by using a genre template.

Brown, Harper and Hedberg (1994) state that theory has suggested a number of software features which could provide metacognitive support for students in computerised, student centred learning environments. These features include dialogue support, worked complex problems, templates for students to keep a log of, the process of their work and cognitive tools that include a brainstorming facility, word processor, multimedia database and spreadsheet, presentation generator and communication facility. The authors see metacognition as something that does not need to be measured but something which can be enhanced to promote learning generally. *Exploring the Nardoo* is an example of an
interactive multimedia program which provides a range of cognitive tools in an information landscape to support student investigations, reflections and thinking processes. Simulations and support tools which allow multimedia reporting are embedded in the package and are supported by several cognitive tools for the writing process. These tools not only include details about genre but also scaffolding templates to support the learners (Harper et al., 1996) in constructing their own realities using the constructs and processes in the environment in a new content domain. Students have a choice in deciding what resource they need to complete a task. This research proposes that metacognitive skill development may be enhanced through interactive facilitation of scaffolding.

*Exploring the Nardoo* has been designed so that students can use the PDA as a repository for information and the genre templates as cognitive tools to help them assemble and represent knowledge in a more meaningful way. Norman (1993) agrees with this notion and contends that computers support reflective thinking when they enable users to compose new knowledge by adding new representations, modifying old ones, and comparing the two. Cognitive tools should be readily accessible to learners to support reflective thinking within the context of learning.

*Nature of the task*

Considering the number of learner characteristics embraced by the term learning style, there will be some learners who prefer to be given a linear directed task with full details of the evaluation criteria, so they can make strategic decisions and process only as deeply as the task requires. Others may naturally desire creative freedom to develop their own ideas to considerable depth, reflect
and self monitor, then determine their own evaluation criteria (Brown, 1996, p. 93).

It is anticipated that at either task extreme, there will always be some students who do not feel comfortable with the situation. Such task-related emotions do not necessarily equate with the amount or nature of material learned, the strategies developed, or the depth of understanding attained in a problem solving process. It is not easy to move out of a comfort zone, and new technology poses its own concerns for many learners. In a constructivist classroom, the challenge is to engage the learner in a self monitoring and self regulating process across a range of tasks (Brown, 1996, p. 94). In the current study, a problem-solving task is used, specifically one involving the use of embedded genre templates.

Our knowledge of the way in which users access and make sense of electronic learning materials has understandably lagged behind the rapid technological developments of the past decade. In an attempt to address this, two recent studies (Cameron, 1997) in Perth investigated linkages between students’ characteristics and navigation performance in accessing data and problem-solving with a CD-ROM learning package and the World Wide Web.

Concern over students’ capabilities and acceptance of the introduction of learning materials presented by electronic means was the reason the researchers undertook these studies. The planned changes were specific to an introductory unit in vocational rehabilitation where occupational therapy students had the opportunity to take a more self-directed approach to their learning utilising information on CD-ROM and the Web. The radical changes from traditional teaching/learning methodologies, focusing on instructor presentation, to a more learner active role, could have

Both studies included the measurement of learner characteristics of participants (n=67) using the following instruments:

- demographic data and technology experience questionnaire;
- learning Styles Questionnaire (Honey & Mumford, 1992);
- group Embedded Figures Test (Witkin, Oltman, Raskin & Karp, 1971) and

The first study involved participants accessing the CD-ROM Vocational Rehabilitation Learning Resource and the second the Web browser Netscape. In each study participants were observed carrying out four groups of tasks: data accessing, browsing, problem-solving and teaching-back to the investigator.

The results showed that a significant number of students (64%) had used computers at home to assist with their tertiary studies on six or more occasions in the past, but that only 21% had accessed the World Wide Web. Eighty-eight percent of the students in this study perceived themselves to be only average or below average in computer knowledge compared to their peers.

The Learning Style Questionnaire results showed that occupational therapy students have a preference for activist and reflector learning styles. For instance, 48% of students displayed a strong to very strong preference for activist learning style, whereas 54% had a low to very low preference for pragmatist learning style. The cognitive style dimension measured in this study showed there was a substantial number of therapy students (78%) who displayed field
independence characteristics. With the technophobia instruments there was a significant number with no technophobia i.e. 57% for computer anxiety and 41% for computer thoughts. However, a substantial number displayed low to high technophobia for each of these dimensions.

In the first experiment, with the multimedia problem-based learning package, a relationship between successful searches and reflective learning style was evident \((p<.05)\). Multiple regression analysis identified cognitive style, reflector and activist learning style, computer thoughts and prior computer experience as being the strongest and most consistent predictors of learner performances measured.

With the second experiment, accessing the Web, there were statistically significant relationship \((p<.05)\) between the number of times that assistance was requested and computer thoughts, computer anxiety, computer knowledge, and computer training. An investigation of the navigation performance variables of the two experiments showed a significant correlation with a number of successful searches with \(p<.001\). Multiple regression analysis produced only weak models for the Web investigation, which could partially be explained by Netscape’s generic design and participants becoming more comfortable and confident with the computer’s interactive multimedia interface. The former aspect supports the claim that multimedia learning materials can fulfill its promise of accommodating learners with different needs (Liu & Reed, 1994). The latter point appears to support the hypothesis that as novice users become more familiar with computer environments learner characteristics have less effect on navigation performance (Rauteberg, 1992).
This study was of use to the current study in that it identified several testing instruments that may be used in an interactive multimedia learning environment. These included the Learning Styles Questionnaire and the Group Embedded Figures Test to determine learner characteristics in accommodating learners with different needs and navigation performance. The above research found a relationship between successful searches and reflective learning style (p<.05). This study also supports the notion that multimedia learning materials accommodates learners with different needs.

Christine Brown (1996) has recently addressed the constructivist information technology classroom. In her thesis she generated a framework for teachers, designers, researchers and learners using interactive multimedia. The framework represents three models to be employed in a constructivist classroom, these being:

- model A-Teaching/Learning Through the Use of Interactive Multimedia Products;
- model B-Teaching/Learning About Interactive Multimedia Production and
- model C-Teaching/Learning With Interactive Multimedia Construction Tools.

Brown (1996) supports the notion that,

Software designed from a more student driven constructivist perspective need not be used by a group, however, the individual user needs to display the motivation and metacognitive skills of a self regulated learner to gain maximum benefit from the software without peer support. Group use may provide a discussion forum for suggestions, ideas and debate, a multitude of learning and problem solving strategies to share, and immediate personal feedback on all communication channels (auditory, visual, body
language). Such group benefits are not automatic, they are only achieved once group members have acknowledged the need to refine such skills as negotiation and collaboration (Brown, in press, p. 206).

The current study draws implications from model A/Learning through the use of interactive multimedia products. Students here may experience a range of pressures and practical difficulties in the use of commercial educational software, such as:

- dislike of the software;
- task completion pressure;
- inappropriate social grouping;
- absenteeism;
- task completion time and
- variations in information input preferences.

This has implications for the current study, in that each of the above issues needs to have been considered. These issues have been catered for by giving participants an orientation session which indicated whether or not they liked the software etc. Task completion pressure was applied too by having teachers select an appropriate task for the discipline area of science being studied in relation to the curriculum. Inappropriate social grouping was acknowledged and classes remained the same for the school term. Task completion time was made explicit to students as it was a normal task assessment and the same amount of time was allocated to students as would have been if they were using any other resources to complete the assessment task. Variations in information input preferences were catered for already because
students did not have to add resources to this program; electronic genre templates were already contained in the software package.

**Genre**

The term genre, suggests Swales (1990), has had a number of meanings, an early definition being a distinctive type or category of literary composition and a class of communicative event in which language and para-language play a significant and indispensable role. Currently, in a more broad sense, it has been defined as a distinctive category of discourse of any type, spoken or written.

Halliday (1993) suggests that literacy learning is not always an effortless process, but it can be difficult for many learners. Genres can be seen as ways through which a culture carries out its communication processes. Knowledge is conveyed through different genres as determined by the culture. Genres can be seen as cultural processes used appropriately according to communicative goals, such as narrative, report, recount, explanation, argument etc. Genre competence is an essential part of the communicative process.

Teachers need to be aware of society’s demands regarding the use of genres in different social contexts and interactions. In addition, a knowledge of genres is an essential component in education for each subject, particularly science, as it has its own genres. For example, scientific knowledge is expressed through a variety of scientific genres. Learning the genres of scientific is learning science itself.

With all information skills, success will only be achieved with immersion and practice. Modelled writing can be used to teach students about writing processes and different types of text. In the
current study students can utilise the modelled writing process and learn about the different types of text when problem solving and presenting the results of their investigations. Good models will help students understand genre and their role in communication by highlighting the structures of the communicative process through example and providing a scaffold on which the student may build.

Hammond's (1991) work suggested that,

It is from the systemic functional linguistic analysis of language, utilising functional grammar, that genre theory has emerged. The conditions of learning between genre theory and whole language are similar in many respects but genre proponents believe that each genre, or register, requires a different linguistic structure, that determines how the content is placed within the text. Genre practitioners, therefore, claim that each genre should be analysed by learners, who need to become familiar with the technical aspects of each in order to achieve maximum control over written language (Hammond, 1991, p. 35).

A review of the literature by Short (in press) has identified the issues in relation to genre theory and the current English K-6 Syllabus (1994) by the NSW Government Board of Studies.

According to Short, while both the Hallidayan and genre approach have gained considerable support in recent years, the reaction within the New South Wales education system has been mixed. In 1990 Christie, a leading proponent of the genre approach, chaired an investigation into teaching English literacy, producing a report advocating a critical social literacy approach to the teaching of English (Christie, 1990). While there was widespread acclaim for the contribution of the study to the field of teacher preservice education, a subsequent study established widespread opposition to what was perceived to be the Report's theoretical narrowness.
(Australian Language and Literacy Council, 1995, p. 22) This recent study seems to support Threadgold's assertions that a solely critical social literacy perspective, based on systemics, overlooked the historical development and any balanced appraisal of cognitive/constructivist/transaction approaches to teaching and learning (Australian Language and Literacy Council, 1995, p. 23).

The latter statement argued for the need to develop a balanced appraisal of genre templates as embedded cognitive tools in a constructivist teaching and learning environment whilst identifying students' cognitions and approaches to learning.

Short's paper (in press) concludes with the following,

> Regardless of the various contentions about the value of a systemic functional linguistic approach in the teaching of English, it seems likely that the knowledge emerging from systemic functional linguistic studies will take a place in the evolving, eclectic conceptualisation of English as a secondary school subject. Given the in-roads already made into the NSW curriculum, as illustrated in the old K-6 Syllabus and the Draft Stage 6 English Syllabus, it seems likely that systemic based approaches will become a part of English teaching in New South Wales secondary schools. The nature of the role it will play, however, remains to be determined (p. 25).

Hand and Prain (1996) also addressed the topic of writing for learning within science classrooms. The researchers presented a model which can be used by teachers to promote a greater variety of writing types within classrooms. They now recognise that there is a need to change the role of language in teaching and learning in science so that learners can construct understanding, enhance the clarity of their personal conceptions and be assisted in producing greater insightfulness of the topic being studied.
Consideration of these issues has led Rivard (1994) to suggest that there are several crucial interconnected factors and necessary conditions that contribute to this learning. These are: the demands on the learner of the writing task; the learner’s metacognitive understanding of strategies to guide the writing; the contextual aspects including a classroom learning environment focused on deeper conceptual understandings rather than factual knowledge; and a complementary match between genre or type of writing, conceptual structure of the topic and broader curricular goals.

The introduction of this type of writing is what the CD-ROM package for this research presents to learners, except that it is presented within an electronic information landscape and can be accessed by the learner at a time suitable to them while completing a task that is also presented within the software package’s information landscape.

The researcher believes that there is a need to broaden the range of writing types used in science classrooms, not merely to expand the options available: moreso, because the act of writing is one in which active learning occurs. By engaging in a particular writing task the individual is required to interact not only with her/his own conceptual knowledge but also with the knowledge addressed within the topic. Limiting writing to copying notes from the board and tests centred on recall of these notes or practiced problems does not maximise interaction with the student’s own knowledge. An argument could be put forward that the student will only learn what is required to pass the test and thus carry two sets of beliefs around with her/him. One is school science knowledge for the classroom, the other is real world science knowledge which students apply to everyday situations and never the twain shall meet.
Exploring the Nardoo, the CD-ROM package used in the current study as a context, does combine the above two scenarios of science knowledge and the twain do meet. The use of different writing types for different audiences requires students to conceptualise their own knowledge from a different perspective. This requires students to decentralise themselves so as to construct a better understanding of the task demands. Students need to address the demands of the audience. For example, such questions as: how much information should be included? What depth of understanding will the audience need or have? Is there a need to carefully explain each scientific term used? Are there some that need to be answered. To begin to answer these questions requires the student to synthesise their understandings into a format which addresses the particular writing type.

Hand and Prain, (1996) supported this notion and believe that,

... the active process of synthesising and reprocessing knowledge extends the student from merely using writing to demonstrate knowledge. The option of asking students to revisit the writing task as they progress through the topic is clearly a powerful means of encouraging them to continually add to their conceptual knowledge. By examining their knowledge at the start, during and on completion of the topic the students become active in monitoring their own understanding. This is certainly a major change in emphasis on the manner in which writing is generally used within the science classroom. Focus on traditional types of writing does not allow for the wide range of learning pathways and strategies that learners use in constructing knowledge, particularly given the movement to adoption of constructivist teaching/learning principles within science classrooms (p. 24).

Swales (1990) suggested that there is an affinity between the situational approach and the learning of the use of language. This can be identified through the operationalisation/exercising of
situation skills, based in an authentic activity, in this case a media rich interactive environment with supportive scaffolds (the knowledge landscapes, templates and the text tablet facility of Exploring the Nardoo package). These supportive scaffolds are for both the preparation and presentation of materials. What is inconsistent in the review of research is how students are coping with embedded genre templates in a student centred learning environment.

The essential aim of the templates in Exploring the Nardoo as suggested by Harper et al, 1997;

is to provide, through modelling of genre and the provision of a scaffold on which the students can build, access to skilling in the different genre characteristic of all discourse communities. In doing this, the package is automatically strongly cross curriculum linked. They may provide a training ground for ... immersion, demonstration, responsibility, and use... (Cambourne, 1991) in the development of presentation skills. They may also provide a means of composing meaning for both the writer and the reader/listener while at the same time providing a means of reflection, re-ordering and creating new learning nodes and links between new and prior knowledge. The production of an effective piece of writing can provide the student with a means of consolidating these links. It can also enhance the students' confidence, self esteem and motivation to stay on and complete a task. The availability of a range of genre templates with added character-guide or text-based support embodies the notion of providing strategies that help them encode the information they encounter suggested by Schroeder and Kenny (1994, p. 963), (p. 24).

Having considered the aim of the genre templates for the current study as part of the learning processes new perspectives for the teaching process may be drawn upon.
Teaching

According to constructivism, the teacher cannot map her/his own interpretations of the world onto the learner because they do not share a set of common experiences and interpretations. Reality (or at least what we know and understand of it) resides in the mind of each person who interprets the external world according to her/his own experiences, beliefs and knowledge.

The teacher's role has now become one of knowledge transmitter (Brown, 1996) if we are to create students who are flexible, motivated problem solvers. Technology offers teachers the opportunity to individualise instruction, place learners in open-ended student centred investigation and shift from their traditional instructor role to that of mentor and co-learner (Harper et al., 1996) facilitator and co-coach. The current study has taken advantage of this idea; students and teachers collaborated to define assessment outcomes. In addition to assessing products of learning it is important to assess the process as well.

Within a constructivist approach, it is also necessary to assess the learners' perspective, understanding the sense that learners make from studying any content domain, may be far more informative than comparing the students' knowledge to the teacher's. It is also useful and informative to have learners create multiple products (perhaps using different cognitive tools) on the same content (Jonassen, 1996, p. 29). In the current study learners can take advantage of producing products using multiple media and cognitive tools in preparing a written response as long as they can support their arguments with evidence from multiple media.
sources. The representation of their product is assessed from the perspective of both the learner and the teacher.

It is important also to design the learning environment to support and challenge the learner's thinking. While one advocates giving the learner ownership of the problem and the solution process, it is essential that the teacher value as well as challenge the learner's thinking. The teacher must not take over thinking for the learner by telling the learner what to do or how to think, but rather teaching should be done by inquiring at the leading edge of the learner's thinking (Fosnot, 1989). This is different from the widely used Socratic method wherein the teacher has the right answer and it is the student's task to guess/deduce through logical questioning that correct answer. The concepts of a learning scaffold and the zone of proximal development as described by Vygotsky (1978) are a more accurate representation of the learning exchange/interaction between the teacher and the student.

When considering the teacher's perspective, several issues remain inherent in justifying technology use. For example will there be increased teacher productivity? Will existing structures require replacing teacher functions versus changing teacher roles? At the moment there is an anticipated view that teachers and schools must remain an important part of the instructional process, but that technology tools will empower them to teach better and use their time more productively. Many technology resources can help teachers increase their productivity in many ways. These include: word processing, spreadsheet, database, assessment records, graphics and authoring package development, desktop publishing, instructional management and test generator programs along with online communications between teachers (e.g. e-mail) and other
online services. Therefore, support tools for children need to be facilitated by teachers within learning environments rather than teachers instructing students with their own preconceived mindset.

When using Multimedia/Hypermedia environments as a resource for cognitive processing and problem solving Idol, Jones and Mayer (1991, p. 80) in the vanguard of providing successful models of teaching to emphasise thinking skills. These include modelling, coaching, inquiry, articulation, reflection and exploration, all of which can be found in Exploring the Nardoo as support for knowledge processing and construction in the formulation of a solution to a problem. The genre templates provide strategies that will help students encode and manipulate the information they encounter. This helps students develop further information and note-taking skills. Teachers can, at any given point, guide students through this process as the students’ own realities unfold.

How teachers use strategies, activities and resources for instruction, whether they be tenants of directed or constructivist approaches in the classroom is dependent upon the knowledge and experiences they have themselves. As stated previously in the literature review, a teacher now has to adapt to the role of being a knowledge facilitator in a bid to create students who are flexible, motivated problem solvers. Exploring the Nardoo offers teachers the opportunity to individualise instruction, place learners in open-ended student centred investigation and shift from their traditional instructor role to that of mentor and co-learner (Harper et al., 1996). The computer and the students’ use of cognitive support tools has the potential to change not only what teachers teach in terms of subject matter or content but how they teach in terms of
process. This raises the question of further researching the potential of multimedia and writing with assistance for learners.

Conclusion

This literature review has called on a number of theoretical approaches to learning to set the context of this study: constructivism, situated cognition, metacognition, learning styles/approaches, assessment and cognitive tools with reference to the learning environment. Genre has been perceived as modelled writing that supports the development of higher order thinking skills and that practice and experience of these skills must be associated with appropriate tasks. Genre and its relationship with interactive multimedia were also reviewed.

For many students the actual collection of materials before writing is a difficult process in itself. Students with poor reading and research skills can be disadvantaged in this process. In addition, the careful and guided use of such supportive structures as the genre templates have been incorporated in Exploring the Nardoo to provide invaluable support for these students by reducing the amount of reading, lowering the cognitive load, in relation to student-centred learning. Genre templates may not only support learners during the writing process, they may provide support for students’ metacognitive processes. Genre templates can provide the means for mapping and exploring new territories, but the empowerment comes with practice, reflection and cognitive (and teacher) support. This empowerment is characteristic of the values and principles implemented in the learning environment Exploring the Nardoo from the theoretical perspective of a constructivist philosophy.
The review of literature provides support for the premise that more research needs to be completed in relation to:

- supporting the broader issues of situated cognition, metacognition, cognitive tools, learning styles/approaches, assessment and the learning environment;

- the understanding of learner use of specific genre templates to scaffold problem solving outcomes, when they have been incorporated into an information landscape within an interactive multimedia software package;

- the role genre templates play in assisting students' writing processes. Genre templates have the potential to play a small but significant role for students with poor metacognitive strategies in the reduction of cognitive load associated with synthesising a written response to a problem solving task;

- adding to our understanding of how learners interact and use the static tools (genre templates) and what metacognitive strategies they employ to synthesise a written response;

- working with a particular type of cognitive tool in a problem-solving context. The results may stimulate development of other cognitive tools to follow a similar research path and to build upon the findings of the current study. Instructional designers, other educational practitioners, and researchers may wish to improve on the genre templates or modify them to apply to other contexts and

- the identification of how students use the genre templates together with the strategies they employ to guide future refinements of these tools.

In summary, the researcher believes that if learners are presented with the opportunity to become aware of their metacognitive strategies when using interactive multimedia they may better understand the relevance of further developing and refining metacognitive skills and perhaps start to use a combination of
cognitive tools in ways not yet understood by teachers and instructional designers to become more self regulated life-long learners. The central theme of the current study has been to identify the connection between a new theory of learning called constructivism, new methods (embedded in new technologies and interactive learning), with scaffolds in the form of genre templates to support learners during the development of higher order thinking skills while problem solving in an interactive multimedia learning environment.
Chapter Three - Research Design

Rationale

The study's underlying rationale was to explore the possible use of genre templates as cognitive tools in a constructivist learning environment. Another dimension to this study was to provide an insight into what type of learning approaches students used in an interactive multimedia learning environment with or without the use of the genre templates.

To address these issues the following research questions and hypotheses were posed. The research hypotheses have been tested in both the pilot stage and research study. They relate to the notion that cognitive support tools, in the form of genre templates, would significantly improve the learning outcomes of students with poor metacognitive strategies. Furthermore, this support could help students with the reduction of cognitive load associated with synthesising a response to a problem solving task. The use of a genre template may also be important to learners as a starting point for the process of organising embedded information when it is presented in multiple modes of mediated representation. An overview of the research questions, hypotheses and data sources for each research question is presented in Table 3.1.
RESEARCH QUESTIONS AND DATA SOURCES

Table 3.1: Research questions with template use and data sources consisting of post treatment questionnaire, interviews, observations and statistical analyses.

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Questionnaire</th>
<th>Interviews</th>
<th>Observations</th>
<th>Statistical</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do the genre templates assist as a cognitive tool to help students make sense out of diverse information?</td>
<td>Q10, Q18, Q24</td>
<td>1, 2, 3</td>
<td>PDA Notes</td>
<td>H1 template use</td>
</tr>
<tr>
<td>2. How does the genre template help the student organise information?</td>
<td>Q14, Q16, Q21</td>
<td>1, 2, 3</td>
<td>PDA Notes</td>
<td>H1 template use</td>
</tr>
<tr>
<td>3. How do students use the cognitive support templates? What approach do students use?</td>
<td>Q4, Q17</td>
<td>1, 2, 3</td>
<td>PDA Notes</td>
<td>H2 approaches to learning &amp; cognition</td>
</tr>
<tr>
<td>4. Is there a relationship between student approaches to learning and the use of cognitive tools in problem solving?</td>
<td>Q2, Q11, Q15</td>
<td>4</td>
<td>PDA Notes</td>
<td>H2 approaches to learning &amp; cognition</td>
</tr>
<tr>
<td>5. Can students identify other tools for support in organising information that is presented in multiple modalities for representation?</td>
<td>Q5, Q6, Q8, Q9, Q12, Q19</td>
<td>1, 2, 3</td>
<td>PDA Notes</td>
<td></td>
</tr>
<tr>
<td>6. What are the implications, from these findings for designers of future interactive multimedia programs?</td>
<td>all</td>
<td></td>
<td>PDA Notes</td>
<td></td>
</tr>
</tbody>
</table>

Template use was investigated by each of the dependent measures. These included student learning outcome measures (total score), style and structure, the gathering of embedded information sources, presentation and quality of argument, with template use. These measures have all been standardised by developing z scores. Table 3.2 contains the hypotheses on template use with their related data sources and statistical tests used.
Table 3.2: Template use with data sources and statistical analysis used

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Questionnaire</th>
<th>Interviews</th>
<th>Observations</th>
<th>Statistical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning outcomes</td>
<td></td>
<td></td>
<td></td>
<td>Student</td>
</tr>
<tr>
<td>H1:1 Students who use the genre</td>
<td></td>
<td></td>
<td></td>
<td>results/</td>
</tr>
<tr>
<td>templates will score higher on</td>
<td></td>
<td></td>
<td></td>
<td>ANOVA</td>
</tr>
<tr>
<td>learning outcome measures than</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>students who do not.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Style</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H2:1 Students who use the genre</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>templates will choose a more</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>appropriate style than students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>who do not.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choice of information</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H3:1 Students who use the genre</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>templates will choose more</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>appropriate information from a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>range of resources than students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>who do not.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Presentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4:1 Students who use the genre</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>templates will present their</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>investigation results more</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>appropriately than students who</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>do not.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of arguments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H5:1 Students who use the genre</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>templates will employ a higher</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>quality of arguments than students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>who do not.</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Student approaches to learning and cognition were measured using the data sources of LPQ, GEFT and Factorial ANOVAS as the statistical analysis used. The hypotheses in relation to approaches to learning and cognition have already been stated in chapter one.

SUMMARY OF DATA COLLECTED

Data relating to the hypotheses and research questions was obtained from a variety of sources. These included:

- students Cognitive Level (GEFT)-Independent variable, given to students before the use of the treatment;

- learning Process Questionnaire (LPQ)-Independent variable, given to students before the use of the treatment;
• the Investigation Result (Learning Outcomes) as measured by the dependent variables; learning outcomes (total scores), style and structure, information gathered, presentation and quality of argument (Assessment protocol);

• PDA notes and Observations of students using the treatment;

• post treatment student Questionnaire responses and

• transcripts of Post treatment interviews from students and teachers.

The GEFT and LPQ as data sources pertain to hypothesis two only.

RESEARCH DESIGN

The design adopted in this study was centred on the manipulation of variables and analysis of data that were collected from the administration of a post-experiment comparison. This approach could be described as fitting the classic experimental design based in the scientific paradigm or rationalistic approach (Guba and Lincoln, 1994).

There are some designs that can be called true experimental designs because they provide completely adequate controls for all sources of internal validity. The posttest only control group design is ideal in that it controls all threats to validity and all sources of bias. The design usually contains two groups, one which experiences the treatment while the other does not, thus controlling for history and maturation (Tuckman, 1994, p. 148).

Borg (1981) suggested that this design was useful in educational studies where differences in pretreatment performance are unlikely. It is also used when the treatment is short since this would lead to a short interval between pretesting and post testing. This approach has been chosen because it controls for threats to internal validity and sources of bias.
In this study, students’ use of the genre templates has been determined by using technology as a context in supporting knowledge organisation and construction, information gathering and representation. An assigned problem-solving task using the software package *Exploring the Nardoo* was given to subjects in both the experimental and control groups with the use of or non-use of the genre template as a cognitive tool to support the process of organising information and presenting as a solution to a problem.

This post measure only control design utilised two groups, one which experienced the treatment *Exploring the Nardoo* with access to the genre templates (Y1) and the control group which did not have access to the genre templates, within the package *Exploring the Nardoo* (Y2). Group assignments were made on a random basis that controlled for selection and mortality. In addition to controlling for simple testing effects and the interactions between testing and treatment, the LPQ as a pre-test was given to both groups. This was to identify whether there were any dominant categories from the LPQ in the groups that may have biased the study. The independent variable for this study was the use of the discussion genre template. Subjects were randomly assigned to treatments, introduced to the software package *Exploring the Nardoo* and tested to determine their learning outcomes from an allocated task within the program *Exploring the Nardoo*. The post measure comparison with randomised subjects can be represented as;

<table>
<thead>
<tr>
<th>Experimental group</th>
<th>X</th>
<th>Y1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td></td>
<td>Y2</td>
</tr>
</tbody>
</table>

The independent measures included the treatment with access to the genre template (Y1) and with no access to the genre template
The research design included an analysis of students' Cognitive Style (GEFT), Student Approaches to Learning (SPQ for the pilot study and LPQ for the research study) with both the independent and dependent measures to identify group membership.

Upon completion of the treatment students completed a post-treatment questionnaire. This questionnaire was developed by the researcher to interpret students' responses after the research design had been administered and dependent measures were collected. The researcher also conducted post-treatment interviews with collaborating teachers and students. This gave the researcher further interpretations on students' use/non-use of the treatment. Cashman and McGraw (1993) discussed phenomenological methods and techniques for conducting this type of qualitative research in instructional technology. Phenomenology places subjective experience at the centre of the inquiry and accepts multiple ways of interpreting events from different individuals via in-depth interviews, regarded by Tsch (1988) as dialogical reflection (Brown 1996, p. 127). Similarly it was important to conduct interviews with the students and teachers to identify whether this data supported the post treatment questionnaire and statistical data. Observations (from students completing the task), the student process notes (from using the personal digital assistant and or the text tablet), generated by the use of the treatment, were also conducted to triangulate the data.

The main method of analysing the qualitative data for this study was through member checking and peer debriefing. Cashman and McGraw (1993) discuss data collection and analysis procedures, referring to field notes, which, consist of detailed descriptions of the setting, events and interaction of participants (Brown, 1996, p. 128).
When discussing data analysis strategies, most researchers find it useful to look for themes, strands, incidents and commonalties in the data as it is collected (p. 211). Moreover, the qualitative data that has been analysed consisted of:

- post treatment questionnaire response;
- transcripts of post treatment interviews and
- student (PDA) process notes and observations of students using the treatment.

The themes found from the analyses of the post treatment questionnaire were compared with the themes resulting from the statistical analyses of template use and approaches to learning and cognition. If variance or commonalties were found they were drawn together in support of the research questions pending peer debriefing.

It was the intention of this researcher to present a holistic view of data rather than a condensed view. In analysing qualitative data Miles and Huberman (1994) outline an interpretive approach that would be phenomenological in nature. They might seek to describe a picture of what is. They would generally not choose to categorise data to reduce it (Jonassen, 1997, p. 1185). This study did categorise data as it was felt by the researcher that this would best ‘describe a picture of what is’ for practical purposes that could be applied by research designers of future software products.

Furthermore, the significance of this study was to identify student interactions with the genre templates so that practical strategies could be further implemented into the classroom. To reiterate, this study investigated qualitative themes and commonalties that were
drawn from students’ interactions with the genre templates and viewed in association with the quantitative data.

Quantitative data analysis made use of the statistics program StatView. Analysis of variance was the general model, variance across a number of variables. These included one continuous variable (Learning outcomes) and one discrete variable (use/non-use of the discussion genre template). ANOVAs were used to analyse the hypotheses on template use, students’ cognition and approaches to learning. The quantitative data that has been analysed included:

- students Cognitive Level (GEFT);
- student Approaches to Learning (Learning Process Questionnaire by Biggs, 1987a);
- learning Outcomes (Student investigation results) and the following subsections from the assessment protocol; Total scores, Style and structure, Information resources, Presentation and Quality of argument marked by multiple science markers;
- data obtained from observations made and collected through Audit Tracking on Template use and
- coded results from the post treatment student questionnaire.

In relation to the methodological issues in the literature, there is little discussion on the types of methods that are incorporated into research areas that look at improving the use of interactive multimedia simulation programs in context. It would appear that observation, interview, survey, pre-testing and post-testing are the preferred data collection techniques (Lee & Lehman, 1993) for the evaluation of using a software product in a specific context. As a result, most of what is known about the effects of computer use on
both learning processes and outcomes is taken from anecdotal material (stories that teachers can tell, usually based on first hand experiences). Consequently there exists an ever-increasing number of case studies, some formal, following a defined research methodology, but many more being informal and incredibly rich in material. On the other hand, Bork (1995) supports the development of an extensive research base of empirical evidence to support the changes that we instigate in learning environments.

The quantitative analysis of comparisons between post measures provided the essential measure of the use of the genre templates and their function in organising information, presented in multiple modalities, whilst problem solving. It was felt by the researcher that a mixed mode approach in the collection of the qualitative and quantitative data would give a balanced yet more succinct view of the use of the genre templates by students. This in turn may give developers of educational software some practical ideas to apply. Salomon (1993) also calls for this mixed method approach for understanding user-information system interactions, using a variety of techniques that seek to uncover the reality of participants. Therefore the methodology for this research was based upon a mixed mode approach using both quantitative and qualitative data to triangulate findings related to a particular problem or question. Furthermore, the quantitative and qualitative research methods employed allowed the researcher to:

- use triangulation to seek a convergence of results;
- use complementary methods to identify overlapping and different facets of a phenomenon;
- bring multiple perspectives to the data;
• add scope and breadth to the study; and

• flexibility to view the phenomena from a number of different vantage points.

To understand whether a mixed mode approach was applicable as a methodology and to test research instruments, a pilot study was conducted.

**PILOT STUDY**

A pilot study took place over a one-month period with a random sample of twenty students. This sample was recruited from students in their first year of a Bachelor of Education primary course as access to year Ten high school students was denied due to the interruption of the school curriculum at the time of the pilot study. It was considered that Year Ten students were fifteen/sixteen years old and the Bachelor of Education students eighteen to twenty years old, learning styles and processes were not excessively different. Under the circumstances, the feedback provided by first year university students was considered as close as possible to a reflection of Year Ten student responses.

The first year students from the Bachelor of Education primary course worked alone at a computer station, which consisted of a Power Macintosh 6100 computer and a colour monitor. Three sessions took place of approximately four hours each, where the researcher introduced the students to a problem solving task and gave a demonstration on how to use the software program and asked them to solve a problem. The same process was used for both treatment and control groups; the only difference being that the treatment group had access and knowledge about the discussion
genre template prescribed in the software package for problem solving.

Complex instruments are a significant cause of poor responses. In this study, this problem has been minimised through the piloting of the research instruments. Quantitative data (SPQ, GEFT, Investigation Results/learning outcomes and Tracking Data) were analysed to see if they addressed the hypotheses. This was to identify whether there were any significant interactions and effects among the variables of student learning outcomes in relation to the research questions.

During this process audit tracking a major technological problem was that electronic storage devices were not adequate. Student disks could not hold student process notes, results and audit tracking logs. Consequently it was decided that it was more important to gather student process notes via a PDA (personal digital assistant) and track them manually through observations.

Qualitative data from a post treatment student questionnaire developed by the researcher was collected to determine whether or not students could understand and answer the questions. Respondents to this pilot study were asked how long the questionnaire took them and whether the instructions for completing the questionnaire were free of ambiguity. Furthermore, they were asked if the questions were clear and understandable. They were also asked if they felt that a topic had been omitted and if the layout was clear (Bell, 1987).

The pilot study resulted in adjustments being made to the procedures used in the design of the research study and the post treatment student questionnaire. For the full study these
adjustments included students completing the LPQ and GEFT on a separate occasion to the study. This reduced the cognitive load as they completed the problem solving task. Other adjustments included student individual use of the package being limited to forty-minute periods; time to complete the task in the main study needed to fit in with the school curriculum. The post treatment student questionnaire itself was adjusted as some students felt that some questions were unclear, mainly due the terminology used. Some questions were removed and regarded as unnecessary or reworded to suit Year Ten students’ vocabulary and comprehension level. However, the sample size of the pilot study was too small to warrant analysis of results and the main aim of the pilot study was to test the instruments and methodology for use in the main study.

One issue that did surface from the pilot study was the need for a well designed marking criterion with reference to the collection of data from the learning outcomes measure (students’ investigation results). A marking criterion (assessment protocol) was designed and developed by the researcher in collaboration with teachers of the students and content experts. The assessment protocol was redesigned to identify and refine the categories for each of the dependent measures of the hypotheses on template use and approaches to learning and cognition. The pilot study resulted in adjustments being made to the procedures used in the design of the research and reworking of the post treatment student questionnaire for the main study.

MAIN STUDY

The operational population for the current study was drawn from an academically selective High School. Entrance to the school is restricted to those who pass a rigid examination in Maths, English
and General knowledge. Furthermore, technological innovation is an important aspect of the school’s curriculum. Sixty-two Year Ten Students were chosen for the study using cluster sampling.

The students selected were all studying two unit science as a core component of the curriculum for the School. Each class, consisting of twenty-one students, was assigned to either the treatment group (Y1), or the control group (Y2). The treatment group contained forty-two students and the control group contained twenty students. These students were accessible for the duration of the research study and willing participants. The students completed a consent form and were assured of their anonymity in research findings and that they could withdraw at any time.

*The site*

The research took place in the high school’s computer laboratories. In recognition of the relationship between media and learning, Clark and Salomon (1986) suggested that one of the drawbacks to studies of media and their impact are that very few situations provide the sustained daily engagement with technology that will afford a reasonable assessment of the impact of technology. This High School, as a site, seemed to provide the investment that Clark and Salomon call for, with as much access to computers as students in regular classrooms have to books, pen and paper. The High school had two computer laboratories that were both utilised for this study. The students were free to use the two computer laboratories for the purpose of this study. No other students were allowed to use the laboratories at these times.
People

The researcher observed and supervised the administration of the research study. In addition, a research assistant helped with any technical difficulties in using the software package *Exploring the Nardoo* when requested indirectly or directly by the student experiencing difficulties. The research assistant also observed students use/non-use of the treatment in the laboratory. Teachers entered the laboratory with their classes and remained with them throughout the duration of their lessons as facilitators. Throughout the research each class had the use of the two laboratories, although it was easier to contain them at times within one computer laboratory.

There were twenty-four Apple Power Macintosh 6300 AV computers set up in the two computer laboratories. The Apple Power Macintosh 6300 had 500 MB of hard drive capacity and at least 8 MB of RAM. All computers in the laboratories were numbered and easily identifiable so each student could always use the same machine, the same CD-ROM and the same floppy disk. Floppy discs were labelled with students' names, CD-ROM number, treatment group number and machine number. This tended to facilitate student direction to machines and resource backup, using a mental checklist. Floppy discs and CD-ROM's were kept by the researcher. They were handed out at the beginning of each lesson, and collected at the end of each lesson. No other media in the form of graphics, word-processing documents or video were needed as students saved their task responses to the floppy disk. These were handed in at the completion of the study to the researcher and teachers for assessment purposes.
Variables

Several variables for the design of this study were selected and identified after an extensive review of the literature. The independent variable consisted of student access to the genre template with examples or no access to the genre template or examples. The moderating variable was the cognitive style that students displayed during learning, represented as data from Student Approaches to Learning. The dependent variables were the student learning outcomes which were further divided up into the following sub sections: learning outcome measures (total scores); style and structure; the gathering of embedded information sources; presentation and quality of argument, based on the use/non-use of the treatment. Content experts identified achievement outcomes and marked the learning outcomes using an assessment criteria. The intervening variable was a continuous variable that identified how students organised information as well as their learning processes. The independent and dependent variables are discussed further in this chapter under Data Collection.

INSTRUMENTS EMPLOYED IN THIS STUDY

The study employed the following variables: students' cognitive style, their approaches to learning, students' use of the genre templates and their learning outcomes and a post treatment student questionnaire. In addition, observations together with student and teacher interviews provided details not easily accessed using other instruments.
**Cognitive style**

Data were collected on students' cognitive style to identify learner interaction with the genre templates. Learners have a cognitive style which can be considered as field dependent or field independent (tendencies). Field dependence (FD) and field independence (FI) are considered to be pervasive, stable cognitive styles that influence a person's perception of messages (McLeod et al., 1978). FD learners are influenced more by their surroundings than are FI learners, who are influenced more by internal factors. FD individuals seem to be more socially oriented and are more affected by praise and criticism from their peers. FD persons tend to take a passive, spectator role in learning. FI learners, on the other hand, seem more adept at taking a message apart and at understanding its component parts and tend to be more active learners who often have a strong self-concept. People are not totally field dependent or field independent, rather they have tendencies one way or the other (Witkin, Oltman, Raskin & Karp, 1971).

Goodenough (1976) defines field independent individuals as analytic or articulate and field dependent individuals as global. According to Willard (1985), this dimension is concerned with an individual's ability to perceive a part of a stimulus as discrete from its surroundings through active and analytic as opposed to passive and global processes. It is also significant to note that the field independence/field dependence dimension is bipolar. According to Witkin and Goodenough (1977), each of the contrasting cognitive styles has components that are adaptive to particular situations, making the dimension value neutral.
Students' cognitive style in this study was measured by using the Group Embedded Figures Test (GEFT). This enabled students to be classified as field independent or field dependent. The GEFT consists of 18 complex figures. Individuals had to find a simple embedded geometric figure which was hidden within a complex one. As in previous studies, students who are at or above the third quartile are designated as field independent. Field dependent were those whose scores on the GEFT fall at or below the point that represents the first quartile. The reliability of this test is .82 for both males and females (Willard, 1985 & Witkin, Oltman, Raskin & Karp, 1971).

One purpose of this study was to establish whether there was a relationship between field dependent and field independent learners and the use or non-use of the genre template. If it helped one particular group and not the other then the researcher and designers of educational software packages need to take this into account and how it may affect the further development of future learning environments to support all types of learners and their approaches to learning.

*Student approaches to learning*

Student approaches to learning have been identified in this study by a Learning Process Questionnaire developed by Biggs in 1987. The Learning Process Questionnaire (LPQ) and the Study Process Questionnaire (SPQ) (Biggs, 1987a, 1987b) have been developed and normed for Australian students. The SPQ has forty-two items and is designed for tertiary students. Students rate themselves on a five-point scale for each item. This instrument was used and tested in the pilot study. The LPQ was used for the main study. It contains thirty-six items, and was designed for secondary students. This
instrument was used to assess the extent to which students endorse the more important approaches to learning and the motives and strategies comprising these approaches.

The three approaches lead to different kinds of learning outcomes. The surface approach leads to retention of factual detail at the expense of the structural relationships inherent in the data to be learned, while emotional or affective outcomes might be feelings of dissatisfaction, boredom or outright dislike. This raises the question of whether a structured relationship is provided; for example, will the use of the genre templates help surface learners with their learning processes and outcomes? The deep approach leads to an understanding of the structural complexity of the task and to positive feelings about it; the achieving approach, particularly in combination with deep, leads to good performance in examinations, a good academic self-concept and to feelings of satisfaction. In the long term, as already mention in chapter two, it has been found that those students who predominantly use deep and/or achieving approaches say they intend to continue beyond their first degree, to Honors or a higher degree of some kind. The composite deep achieving approach is the one most associated with the attributes of formal education (Biggs & Moore, 1993). This does depend on what type of approaches learners take when they use the templates to complete a task and the kinds of outcomes they produce.

The templates may also support surface learners in recognising some of their metacognitive strategies. Learning approaches, especially deep and achieving, are most effective when students are consciously aware of their own learning processes and try deliberately to control them. In this important process called metalearning, students adopt those strategies that are congruent
with their motives. If they are curious (deep motive) they will want to find out and understand all that they can about it (deep strategy). If they want to achieve top marks (achieving motive) they will organise their approach accordingly; for example study according to a schedule, hand assignments in on time (achieving strategy). Again this raises the issue of using this instrument to identify whether students who use the genre templates are aware of their metacognitive processes or not. Do they use or not use the genre templates as part of being aware of and controlling their own learning processes? If they do, do they produce better results and does this depend on a student's profile?

As already stated, a student's profile represents the general orientation towards learning or learning style, which is typical of that learner (Biggs & Moore, 1993, p. 13). The current study used the LPQ (Biggs & Moore, 1993, p. 130. The scoring details for the LPQ profiles, according to the handbook suggested scoring deciles for surface motive and strategy, deep motive and strategy and achieving motive and strategy. Interpretations of these profiles can be found in Table 3.3.
Table 3.3: Teaching decisions and some LPQ profiles

From (Biggs & Moore, 1993, p. 17), Table 3 Teaching decisions and some LPQ profiles in Using the LPQ in the classroom.
Table 3.4: LPQ categories devised from LPQ data sources in the main study

<table>
<thead>
<tr>
<th>Categories from new decile ranges</th>
<th>Data obtained from students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Deep = 7</td>
<td>- - + + 0 0</td>
</tr>
<tr>
<td></td>
<td>- 0 - + - -</td>
</tr>
<tr>
<td></td>
<td>- - + 0 - -</td>
</tr>
<tr>
<td></td>
<td>+ 0 + - -</td>
</tr>
<tr>
<td>2. Achieving = 6</td>
<td>0 - + 0 + +</td>
</tr>
<tr>
<td></td>
<td>- - 0 0 + +</td>
</tr>
<tr>
<td></td>
<td>0 - - 0 + -</td>
</tr>
<tr>
<td>3. Deep Achieving = 15</td>
<td>- 0 + 0 + -</td>
</tr>
<tr>
<td></td>
<td>- + + + + -</td>
</tr>
<tr>
<td></td>
<td>- - + + 0 0</td>
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<tr>
<td></td>
<td>+ - + + + -</td>
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<tr>
<td></td>
<td>+ + 0 + + -</td>
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<tr>
<td></td>
<td>0 + + + + -</td>
</tr>
<tr>
<td></td>
<td>0 + + + + -</td>
</tr>
<tr>
<td>4. Surface Achieving = 8</td>
<td>+ + + + + +</td>
</tr>
<tr>
<td></td>
<td>+ + - + + +</td>
</tr>
<tr>
<td></td>
<td>+ + + + + +</td>
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<tr>
<td></td>
<td>0 + - + + +</td>
</tr>
<tr>
<td></td>
<td>0 + - + + +</td>
</tr>
<tr>
<td>5. Surface = 8</td>
<td>+ + - + - -</td>
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<tr>
<td></td>
<td>0 + - - - -</td>
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<td>+ - 0 - - -</td>
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<tr>
<td></td>
<td>- + - 0 0 -</td>
</tr>
<tr>
<td></td>
<td>+ + - 0 - -</td>
</tr>
<tr>
<td>6. Low Achieving = 19</td>
<td>- 0 - 0 - -</td>
</tr>
<tr>
<td></td>
<td>- - 0 0 - -</td>
</tr>
<tr>
<td></td>
<td>- - - 0 - -</td>
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<tr>
<td></td>
<td>0 0 0 0 0 -</td>
</tr>
<tr>
<td></td>
<td>0 0 0 0 0 -</td>
</tr>
<tr>
<td>Others that did not fit into a category and were removed.</td>
<td>+ + - + - -</td>
</tr>
<tr>
<td></td>
<td>0 + 0 + - -</td>
</tr>
</tbody>
</table>
The student profiles in Table 3.4 were derived from the following ranges and deciles:

Above average (deciles 8, 9 and 10) as +, Average (deciles 4 to 7) as 0 and Below average (deciles 1 to 3) as -. These deciles were then translated into student profiles using the suggested ranges. The profiles are represented in Table 3.3. However, Biggs & Moore (1993, p. 13) also claimed that these deciles are 'arbitrary' and that if one decided to be more stringent, one could restrict + and - to deciles of 10 and 1 respectively or 10, 9 and 2, 1 respectively and that these matters require further research. After completing an analysis with the first set of decile ranges the researcher found that there were not enough data available to represent all the categories in Table 3.3 and give a balanced distribution. For example as there were only three people classified as deep re the first set of decile ranges, this was found to reduce the power of the statistical analysis. It was decided by the researcher after personal communication with Biggs (1998) to change the deciles to the following ranges: above average (deciles 7, 8, 9 and 10) as +, average (deciles 5 to 6) as 0 and below average (deciles 1 to 4) as -. This provided the researcher with a greater representation of the following categories: Deep, Achieving, Deep Achieving, Surface Achieving and Low Achieving as represented in Table 3.4 (Biggs & Moore, 1993, p. 17). This now gave the researcher a wider range of categories using the initial study data. The data were categorised into student profiles as initially suggested in Table 3.3 on teaching decisions and LPQ profiles. After having identified student profiles these needed to be compared with students' use/non-use of the template as predictors of greater learning outcomes.
Learning outcomes

For this study the investigation result is an outcome, based upon the results of a problem solving task within the software program *Exploring the Nardoo*. An outcome refers to declarative knowledge of taught content, which includes both coverage and structure of knowledge, originality and transfer to new situations. Various testing formats have been devised for each kind of outcome, these include; objective test, especially multiple choice and short answer, and learning outcome, essays, concept mapping etc. (Biggs & Moore, 1993). For the purpose of this study the learning outcome has been derived from students’ investigation results and is referred to as an essay.

In this study, student learning outcomes were the result of a writing task. Jonassen (1996) states that:

> Writing demonstrates both comprehension and composition skills including inventing, revising, elaborating, defending and stating ones ideas to fit the purpose and the audience. In addition, it demonstrates students' knowledge of context specific language and the correct situational usage of syntax and grammar (Feuer & Fulton, 1993). For writing to be used effectively it should be focused on a real world problem or event, so writing about current controversial topics is likely to produce the best arguments. Also the writing task should be directed at a specific target audience that is commonly associated with such a task (For example, letter to the editor of the local paper) should be written from the perspective of a professional or expert (p. 278).

This study sought to include such a task, requiring students to investigate a problem. They were then required to gather evidence from embedded resources and synthesise a response for a target audience; for example, a newspaper article, written from the
perspective of a journalist. One way of identifying what learners know and how they have come to know it, was through the development of the learning outcomes assessment criteria, developed by teachers and students with each of the sub sections as dependent measures.

Often, traditional tests and testing methods fail to measure important education outcomes. They emphasise homogenised recall of memorised factual knowledge and procedures rather than unique and highly differentiated reflection. Because traditional tests judge performance based on external criteria, they typically emphasise standards which can be applied to typical students. In order to be useful in promoting higher order thinking skills, testing needs to shift from domain referenced evaluations to student centred assessments. Student centred assessment emphasises the ability to diagnose and manage cognitive growth rather than evaluating student achievement (Jonassen, 1996).

In this study, content experts marked the completed task (an essay/newspaper article) and a final grade on their learning outcome was given to the students. The assessment method used for this task was based on performance assessment. Performance assessment refers to the process of asking the student to produce things or to perform tasks that require given skills. Performance assessment requires a collection of complementary sources such as observations of student performance, exhibits, presentations, interviews, student generated projects, simulations and role-playing (Dana & Tippins, 1993). In order to be authentic, the performance must have some connections to the real world or some aspect of that world: that is it must be an application rather than a recollection of knowledge. Appropriate performance assessments
reflect the complexity of real worlds and measure many facets simultaneously.

Performance assessment involves the presentation of a task, special project or investigation associated with either a routine or a problematic situation. For example, assessments in science might examine the handling of devices for experiments, the design of experiments to test hypotheses and the development of argumentation supported by empirical evidence. The latter is the case for the investigation results from the problem solving task given to participants that are employed in this research. The outcome of the task that was presented to students involved the development of arguments for and against a particular issue that needed to be resolved. During performance assessments, students have the opportunity to demonstrate wide-ranging abilities. The performance task allows students to function in roles similar to those expected in real world settings. Through performance assessments students recognise that learning is not simply an exercise in memorisation, but one of developing a sense of both the depth of particular disciplines and an appreciation for the complexity of areas under study (Dana & Tippin, 1993).

Performance assessment of higher order thinking skills allows students to demonstrate their understanding and comprehension of concepts during problem solving.

Experimental materials

*Exploring the Nardoo* is an interactive multimedia software program which supports a constructivist approach to learning. It incorporates problems that challenge students to become active participants in the learning process. *Exploring the Nardoo* provides
the student with a flexible set of tools made available through a personal digital assistant to assist in the investigation process. This package also provides the ability for students to record thoughts and impressions during learning whilst examining media stories. It holds the potential for students to reorganise or revise their thoughts to better make sense of what they see and hear. Students are able to document their emerging ideas in support of an investigation or problem solving exercise whilst viewing different media. This further supports the formulation of new schemata during the process of accommodating new information. *Exploring the Nardoo* is an example of a product which offers a range of cognitive tools in an information landscape to facilitate student investigations, reflections and thinking processes. Simulations and support tools that allow multimedia reporting are embedded in the package and are reinforced by several cognitive tools for the writing process. These tools not only include details about genre but also scaffolding templates to help the learners (Harper et al., 1996). Genre descriptions can be viewed and a genre template can be copied into the notes and used as a scaffold upon which to build or fill-in relevant information found whilst exploring the package.

To facilitate the re-ordering or re-prioritising of information *Exploring the Nardoo* provided a separate, expanded form of the notebook. This device has been termed a ‘text tablet’ (TT). It provides the editing facilities offered by the ‘personal digital assistant’ (PDA) as well as other features to assist with the restructuring of notes into a form more suited to small group presentation or a particular genre style. The text tablet provides a larger expanse of editable screen/document space into which student notes may be copied to/from the PDA notes module.
A writing genre template can also be loaded directly into the text tablet into which portions of the student’s notes may be copied or dragged. Notes from prior sessions can be loaded into the text tablet and used in support of current investigations. Being able to store and report thoughts and impressions derived from media experiences by using the media itself (actual video/audio and pictures not just text representations of the media) provides a more powerful means of ‘reformulating’ (Schroeder & Kenny, 1994, p. 965) ideas. The multimedia collection, editing and presentation facilities offered within Exploring the Nardoo are extensive and provide a great potential for students to become manipulators of multiple media. New avenues are opened for expression for those who choose to use the facilities within the package. However, as Kenny and Schroeder (1994) point out learners’ not accustomed to this technique and multimedia facilities will require instruction in its use before they become proficient with the technique but once accustomed to it the student has a powerful process at her/his disposal to gather, organise and illustrate her/his ideas. Support for teachers and students in the use of these features is also modelled in walk-through movies made available through the help system and also detailed in support notes available in reference books within the package. In this study, before students could use the genre templates as the treatment they had to be given a task.

The task that was used in this study was detailed in the software package. Students were told which task to select for the purpose of the research and how to locate the task. An example of this task is found below:

Assessment Task (Appendix A)

Time Zone 3:1960’s-70’s
Merringurra Region

Dam Construction

Pilliga Dam has been constructed in the Merringurra Region of the Nardoo River. At the time of development, environmental groups were concerned about the effect that the dam may have on the Nardoo River valley.

Your task:

Investigate the issues surrounding the construction and impact of Pilliga Dam and write an article for the local newspaper that discusses the effect the dam has had on the area. (Harper et al., 1996).

The Assessment task was given to all participants after the researcher gave an orientation session. Knowledge, information and representation of the genre template structure were only available to the experimental group. All references to the use of the genre templates for the control group were turned off, using programming techniques employed by the developers of the software package, after having gained their permission.

Genre templates

The essential aim of the templates in Exploring the Nardoo (Harper et al., 1996) was to provide, through the modelling of the different genres and the provision of scaffolds on which the students can build, access to skilling in the different genre specific to and characteristic of the various discourse communities. In doing this, the package was automatically strongly cross curriculum linked. It was thought that the templates could provide cognitive support for problem solving and the development of other higher order cognitive skills by providing a framework for student presentation
which may concentrate thought and facilitate investigation and the development of critical and creative thinking. They may provide a valuable training ground for demonstration, and immersion in the use of genre as well as the fostering of student responsibility in the development of presentation skills and hence quality responses to problems.

The use of the genre templates in this study also sought to provide a means of composing meaning for both the writer and the reader/listener, while at the same time providing a means of reflection, re-ordering and creating new learning modes and links between new and prior knowledge. The production of an effective piece of writing or presentation in any media can provide the student with a means of consolidating these links. It can also enhance the student's confidence, self esteem and motivation to stay on and complete a task. The availability of a range of genre templates with added character-guide or text-based support embodies the notion of providing strategies that help them encode the information they encounter suggested by Schroeder and Kenny (1994, p. 963).

For many students the actual collection of materials before writing was a difficult process in itself. Students with poor reading and research skills can be disadvantaged in this process. The careful and guided use of such supportive structures as the genre templates incorporated into the software package (as the treatment) provided valuable support for these students with poor reading and research skills, reducing the amount of reading and lowering the cognitive level (Harper et al., 1996). Another way of identifying the way in which students collected their information when organising
knowledge and information to synthesise a written response to a task was to track their learning processes.

**Audit tracking (PDA notes and observations)**

The Audit Tracking process used in this study involved the collection of Student Process Notes using the Personal Digital Assistant (PDA). The purpose of this was to identify student use of the genre templates within the CD-ROM. This was to enable the researcher to obtain data on the progress of students use of or non-use of the treatment. This could be regarded as the inclusion of computer logs by the recording of student actions (Fritze, 1994, p. 281). A particularly difficult issue in multimedia learning environments is assessing the trail taken by individuals through instruction. How does one track the performance of an individual transversing multimedia learning systems in which the learners may follow a seemingly endless number of paths through instruction? Audit trails (records of all responses a learner makes while engaged in interactive or hyperactive mediated instruction) offer several approaches to data collection. The difficulty presented by audit trails is twofold: how should data be collected and how can one make sense of the data? The first difficulty has been addressed successfully in the literature. Data can be collected and represented in various statistical and graphic forms (Beasley, 1992; Misanchuk & Schwier, 1992; Williams & Dodge, 1993) and hypermedia routines are available that can be used to automate data collection (Beasley, 1992; Williams & Dodge, 1993). Once collected, Misanchuk and Schwier, (1992) cited by Fritze, (1994) suggest that audit trail data can be put to at least four uses: formative evaluation; basic research in instructional design; determining patterns of usage in public displays; and counselling or advising learners.
For this research study logs of students' actions and observations were recorded through the use of the personal digital assistant (PDA). The PDA is an electronic student notebook contained within the software package. Students used the PDA in the process of collecting embedded resources in helping them to complete their tasks. Treatment of this data consisted of statistical and categorical analysis of themes and patterns. The themes represent the movement of an individual student between the different screens within Exploring the Nardoo. These included resources gathered at each screen, whether or not students had used or copied the template together with how students displayed their process notes when collecting and gathering information in synthesising a response to a task. The investigation results (learning outcomes) were then recorded on students' floppy discs along with their learning outcomes and analysed, depending on which group they were in and whether or not they used the treatment. One way to cross-reference whether or not students had done what their learning outcomes indicated with what they said they had done, was to compare their logs with the post treatment student questionnaire. This was also used as a means of data collection, although the assessment criteria did comprise of data based on evaluation and numerical values.

Post treatment student questionnaire

For this study, another way of identifying what learners know about their learning processes was to collect further data responses from the post treatment student questionnaire. The post treatment student questionnaire was based on learning processes about template use, designed by the researcher and tested in the pilot study. The questionnaire was given to each participant after the use
or non-use of the treatment. The protocol included structured and open-ended questions. Open-ended questions were used to elicit participants’ perceptions and knowledge about their learning processes. All information gathered in the questionnaire was reviewed so that the researcher could gain further insights as to whether moderating variables had an effect on the investigation results and in turn on the use of the genre templates with student learning outcomes. To counteract the difficulty of students’ who choose not to answer certain questions in the questionnaire other measures of collecting data were used. This was so that the researcher did not lose valuable data that related to the research questions; One of these measures was audit tracking, by observing students’ process notes as already discussed in this chapter. Other measures included the collection of data through interviews and observations.

**Interviews and observations**

Interviewing allowed the researcher to investigate the topic in all its complexity. The aim of the interviews was to ascertain an in-depth understanding of how learners processed knowledge while completing a task with the use or non-use of the genre template.

The interviews started with descriptive questions to help build rapport and to give the collaborating students and teachers time to organise their thoughts. The interviews were conducted in a non-threatening, friendly atmosphere. The researcher listened attentively, sometimes using a reflective probe strategy to cross check what had been said. The students and teachers were given a summary of what they had said and were asked to confirm or to clarify that interpretation. The intent of these strategies was to
understand the participants' perspective. These strategies were also used as forms of validity checking.

Asking open ended questions allowed the researcher to gain insights into how and why the respondents think the way they do from their own frames of reference rather than one structured by pre-arranged questions. Since any interview necessitates dialogue between two or more people, the interviewer was aware of any influences she may have exercised on the interviewees' responses, such as through asking leading questions, tone of voice and body language. For this study the interviewer needed to have good listening skills and be able to interpret visual cues such as changes in the interviewees' facial expressions, voice and so on. Prompts and probing questions were used and posed carefully to avoid bias.

**Assessment protocol**

The teachers of the classes used in this study felt that there was a need for a criterion to be employed that had been jointly created and developed by them and the students. The teachers played a major role in developing a marking framework and guidelines for the learning outcomes and assessment criteria. The teachers believed that such tools would be more likely to result in fair and equitable assessment outcomes. Additionally, some of these teachers had extensive experience marking the final year state examination administered by the Department of School Education and were very familiar and comfortable with this type of protocol. Comments from teachers on this issue were used and refined to develop the assessment guidelines for the student solutions (learning outcomes). This assessment protocol was trialed and again refined by the teachers, the researcher, the students and through
interviews with other English teachers. It was again trialed, then re-formed by including subgroups of the learning outcome measures. These consisted of total scores, style and structure, information sources, presentation and quality of argument.

The assessment criteria were then given to the students at the beginning of the problem-solving task with evaluation and numerical values to be placed on the student learning outcomes and subsections. The assessment protocol was then marked by the teachers and remarked by content experts to see if there were any inconsistencies and handed back to the students with numerical values and comments placed on the appropriate sections. The marks given for each of these sections made up the numerical mark for students’ total score as indicated below in Table 3.5.
### Table 3.5: Assessment protocol

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Marking Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 1. Appropriate style chosen and used</strong></td>
<td>5 marks</td>
</tr>
<tr>
<td>- For research purposes only please circle one of the following;</td>
<td></td>
</tr>
<tr>
<td>Key - 1 as low evidence of and 5 as high evidence of</td>
<td></td>
</tr>
<tr>
<td>• A. Evidence of appropriate structure</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>• Title:</td>
<td></td>
</tr>
<tr>
<td>• INTRODUCTION Introduces the issue and gives some background information</td>
<td></td>
</tr>
<tr>
<td>• ARGUMENTS FOR:</td>
<td></td>
</tr>
<tr>
<td>• (1)</td>
<td></td>
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<tr>
<td>• (2)</td>
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<td>• (3)</td>
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<td>• ARGUMENTS AGAINST:</td>
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<td>• (1)</td>
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<td>• (2)</td>
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<tr>
<td>• (3)</td>
<td></td>
</tr>
<tr>
<td>• CONCLUSION</td>
<td></td>
</tr>
<tr>
<td>B. Evidence of appropriate language</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Guides/ introduction</th>
<th>Background/ Context</th>
<th>PLEASE TICK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional info(1)</td>
<td>Take Measurements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Explore Merringurra</td>
<td></td>
</tr>
<tr>
<td>Additional info(2)</td>
<td>Effect Wetlands</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Filling Cabinet</td>
<td></td>
</tr>
<tr>
<td>Embedded information</td>
<td>Cotton Farmer (R)</td>
<td></td>
</tr>
</tbody>
</table>

#### Section 2. Information chosen from a range of resources, 5 marks

<table>
<thead>
<tr>
<th>Guides/ introduction</th>
<th>Background/ Context</th>
<th>PLEASE TICK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional info(1)</td>
<td>Take Measurements</td>
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<td>Additional info(2)</td>
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<td>Filling Cabinet</td>
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</tr>
<tr>
<td>Embedded information</td>
<td>Cotton Farmer (R)</td>
<td></td>
</tr>
</tbody>
</table>

#### Section 3. Presentation 2 marks

#### Section 4. Quality of arguments presented (see section on levels 1-8 below) 8 marks

**Total** 20 mark marks

- Student Name and Id ...............................................................
- See note to markers
Note to markers only. for section 4. quality of argument marking criteria see below.

Level 8 - HD
The solution is complete and provides a clear and accurate explanation of possible solution(s) to the problem. It includes appropriate references to supporting media, identifies relevant information and clearly communicates/presents the evidence to support the argument in a logical and coherent manner.

For a detailed description of this criterion please see list below:

Supporting media and identifies relevant information

Concrete supporting details
-examples of illustrative incidents, figures and statistics, ideas supported by facts/examples for her/his views, i.e., facts versus opinions.

Originality-Do the products represent the student's original thoughts or are they copied from sources or other students?

-acknowledges credible sources of information about the topic (to obtain this level for this particular task students, must have measurements before and after dam and at least one picture and no videos).

Inference-Are the students about to make hypotheses and conjectures based on the information in their products?

-valid/invalid argument

-deductive/inductive

Predicability-Are the students able to solve the kinds of problems faced by citizens, consumers and professionals in the field?

Logical and Coherent Manner

Kinds of Logical Order

-chronological order

-logical division of ideas

Contextual relevance-Do the learners' responses reflect representations of the contexts encountered in a field of study or in the real test of life?

-order of importance

Coherent Manner

Coherence-Are the relationships that are expressed in the product meaningful and appropriate and are they consistently used?

-coherent manner, order and reasoning, complexity of thought/depth of research.

Repertoire of knowledge-Did the students' responses call on a repertoire of knowledge and judgment in different forms that is a mixture of declarative, structural and procedural knowledge?

Clearly communicates/presents

-skills in presenting argument does/does not come across,

Resource/tool use-Do the students make effective use of the resources and tools that were made available during the activity and those commonly available in the real world?

-language appropriate for logic and audience, students can articulate sentences and structure of argument,

-main points, unity and simple outlining are included.
Note to markers only continued

<table>
<thead>
<tr>
<th>Level 7</th>
<th>D+</th>
</tr>
</thead>
<tbody>
<tr>
<td>The response is fairly complete and includes a reasonably clear understanding and possible solution to the problem. Arguments are presented, together with appropriate supporting evidence but ideas are not as clearly expressed as in level 8. To obtain this level students must have some measurements and no videos.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 6</th>
<th>D-</th>
</tr>
</thead>
<tbody>
<tr>
<td>The response is satisfactory but is lacking in appropriate supporting evidence and lacks clarity in the presentation of ideas.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 5</th>
<th>C+</th>
</tr>
</thead>
<tbody>
<tr>
<td>The response is incomplete in that appropriate supporting evidence has been omitted. The answer does not show a full understanding of the problem or lacks clarity in presentation of arguments to support possible solution(s).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 4</th>
<th>C-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student attempts problem but cannot analyse/interpret/construct a possible solution or argument. Shows little understanding of the problem solving process and presenting the arguments.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 3</th>
<th>P+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little attempt at construction of possible solution or argument, there is a lack of evidence to support the argument and development of a possible solution. There is little evidence of problem solving skills.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 2</th>
<th>P-</th>
</tr>
</thead>
<tbody>
<tr>
<td>No attempt at development of possible solution.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 1</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>No response</td>
<td></td>
</tr>
</tbody>
</table>

Section 4. Quality of arguments presented in Table 3.5; of the marking criteria; was developed from the levels above. Each of the teachers judged students' work and gave them a mark in relation to that level of skill used. All teachers had use of the levels and collaborated on interpretations so as not to bias the marking protocol. The teachers also discussed what Section 3. Presentation represented and how this would be interpreted in relation to the task outcome. The outcome of the task was to write a newspaper article, restricting the article to only one or two multimedia examples. Section 2. Information chosen from a range of resources were rated by the content experts as to what resources were more appropriate. Students were not simply given a mark for the number of resources they chose, but also for the most appropriate piece of information that was used as evidence in support of their argument. Markers did select primary and secondary resources and a combination of the two. Examples of these are contained in Table 3.5 in the box of the assessment criteria under section two. Section
1. Appropriate style chosen and used consisted of giving students marks in accordance with evidence as to whether students had used the template structure. This was also cross-checked with the post treatment student questionnaire designed by the researcher and given to participants at the completion of the treatment. Furthermore, question twenty from the post treatment questionnaire was posed to students in the experimental group asking them if they had accessed and used the template structure.

DATA COLLECTION PROCESS

Table 3.6. summarises the data collection process using the instruments outlined in the previous section.

Table 3.6: Data collection

Experimental group

| Students Sessions GEFT FI/FD LPQ | Orientation session Instruction Nardoo Given to all participants Treatment Genre Templates Learning outcomes PDA Process Notes and Observations Post Treatment Student Questionnaire Interviews and Observations Assessment Protocol collected from teachers Session Hours one group |
|----------------------------------|-------------------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| E Group x 42                     | 20 min                                          | 30 min                          | 2 hrs                           | 8 hrs                           | 10 min                          | 30 min                          | 12 hours                        |                                  |                                  |

Control group

| Students Sessions GEFT FI/FD LPQ | Orientation session Instruction Nardoo Given to all participants Treatment Genre Templates Learning outcomes PDA Process Notes and Observations Post Treatment Student Questionnaire Interviews and Observations Assessment Protocol collected from teachers Session Hours one group |
|----------------------------------|-------------------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| C Group x 20                     | 20 min                                          | 30 min                          | 2 hrs                           | 8 hrs                           | 10 min                          | 30 min                          | 12 hours                        |                                  |                                  |

Before the treatment was administered, all subjects were given a consent form by their teachers to be filled out by them and their parents. This was according to the procedures for the Department of Education approvals to complete research in a school-based setting. The teachers collected and recorded the consent forms. Out of the
one hundred and five subjects chosen for this research, only sixty-two subjects were made available. The subject coordinator and the Principal found it too difficult to timetable a larger number of classes within the Year Ten science stream. Organisation with the head teacher of the Science department to include testing, and the use of the software package in the year Ten science program as part of the curriculum, had been negotiated prior to the study commencing. It would have been too imposing and a disruption to adjust the timetabling further. Five students did not complete the research, as their parents did not give their consent.

LPQ and GEFT

Before the treatment was administered, all subjects were given the Learning Process Questionnaire (LPQ) and the Group Embedded Figures Test (GEFT) (Witkin, Oltman & Raskin, 1971). The reason this was given before the orientation session was so as not to bias the study. The researcher felt it was necessary to find out if the categories from the LPQ were represented evenly in both the treatment and control groups. If one group had all surface learners and the other all deep learners then the study would be neither effective nor ethical. As it happened there was no significant difference found for the categories from the LPQ in the treatment or control group. A similar situation needed to be clarified for the GEFT. The GEFT was used to determine whether students tended to be field dependent (FD) or field-independent (FI) learners. These learner characteristics were examined because it was felt that the impact of the treatment might be different for subjects who were either FD or FI. Subjects were given the GEFT, then were categorised as being either FD or FI, depending on their score on the GEFT
Orientation session

Before the use of the treatment the researcher presented an orientation session for all subjects in relation to the use of the software package *Exploring the Nardoo*. The orientation session was delivered in the form of a verbal protocol, together with the use of the help videos already provided in the software package itself. There was no discussion on the use of the genre templates during the orientation session as the researcher felt that it might bias the study. The orientation session provided an overview on how to navigate through the software package. Students were then allowed a period of one and a half hours to explore, investigate and use the software package. Students in both groups may have come across a variety of embedded cognitive tools and resources during the exploration process. During the orientation session no questions were raised by the students regarding the technology tools, simulators or any of the cognitive tools. Students were too eager to begin exploring themselves. After this process had occurred, the students would then indicated to the researcher when they felt comfortable in using the package. The researcher then assessed the students knowledge of the software package from the orientation session by giving them a quiz, via a verbal protocol.

The verbal protocol consisted of quiz questions to the students to indicate whether they had competent computer literacy skills, a thorough understanding of the software package capabilities and navigation procedures. Students were then told how long they had to work on the investigation. They were also told that the aim was
to carry out the task and or to learn as much as they could about the topic while producing an investigation result. Students were also informed about the role of the researcher (non-participant observer) and this was explained to the students. In addition, the students were told that they could ask the observers (researcher, research assistant and their teachers) for help in using the program but that the researchers would not interfere with the completion of their assessment task. A research assistant was employed for the duration of the data collection process.

The role of the research assistant was twofold. The research assistant was used as a technical support person as the school’s computer Laboratory consisted of two rooms. The researcher could not be in both rooms at the same time. The research assistant was also used as an observer and helped the data collection process by gathering observations based on a protocol developed by the researcher. Once all students had completed the quiz, the roles of the people involved in the administration of the research process had been discussed and students given the opportunity to ask questions and resolve technical problems, the orientation session was complete and students were given the treatment.

Treatment

A CD-ROM called Exploring the Nardoo used for the treatment and a blank floppy disc with an identification number on it, were given to students at the beginning of the research process, indicating that they were ready to start the treatment. The purpose of students having a number on their CD-ROMs and floppy discs was so that students would be using the same versions of the software, to avoid technical problems and to keep track of the data collection process.
All of the data were collected, numbered, colour coded and cross-checked by the researcher using an updated spreadsheet during and at the end of the study. The data were collected by the researcher each night during the research process, and stored away to prevent bias to the research process as several of the students were keen to keep working after hours. The researcher also had to keep track of which group was using which CD-ROM, because the control group were using a CD-ROM that had the use of the genre templates and access to knowledge about them turned off. Even though the control and treatment groups completed the administration of the research process at different times, if the CD-ROMs’ were mixed up between the groups this again would bias the study. The researcher made sure that all participants had equal time in using the treatment by recording how much time each person had on the computer with her/his CD-ROM. At the completion of the treatment students handed the researcher their CD-ROMs (used for the treatment), floppy disc with their investigation result (learning outcome) and process notes (PDA). After completion of the treatment, students proceeded to complete a hardcopy of the post treatment student questionnaire. This was then handed to the researcher.

*PDA notes and observation protocols*

Student process notes were kept using the Personal Digital Assistant (PDA) from the software package and stored with their learning outcomes as a separate file on their student floppy disk. These were collected and stored on a central server then printed out at a later date and analysed. Hard copies were stored by the researcher and used for later review. Observations of students using the software package and completing the task were recorded by the researcher.
and research assistant during the study and analysed in conjunction with students' process notes.

Post treatment student questionnaire

A post treatment student questionnaire was collected after the treatment. Students filled out the hard copy and were asked to attempt all questions. The students in the experimental group had the same questionnaire as the control group, except that from Question Twelve onwards they had questions that pertained to the use of the genre templates. All questions from the questionnaire were completed after each student indicated that s/he had completed her/his investigation results and had handed these to the researcher. The post treatment student questionnaire was then collected by the researcher and several students at random were selected to be interviewed and given a time and place to meet with the interviewer (researcher).

Interviews

In addition to the data that had already been collected after treatment use, eight student and three teacher post treatment interviews were conducted. These, and observations during and after treatment use, were made and used in triangulation of the data to ensure validity, trustworthiness and reliability. Student responses were read many times and through extensive reflection, transcribing and coding, several categories began to emerge. These categories were then analysed. A small sample of responses were selected as representative of the views expressed. Students were then invited to read the transcripts to ensure that the transcription properly reflected their intended responses.
The assessment protocols (marked proforma from students’ investigation results/learning outcomes) were collected from teachers and content markers three weeks after the administration of the research. This was because teachers needed time to mark the investigation results as did the content experts. These were then collected and reviewed by the researcher to see if there were any discrepancies or significant differences between the teachers’ and the content experts’ marks.
Chapter Four - Data Analysis and Results

This chapter begins with a statistical analysis of data with reference to hypotheses on genre template use, and also reports on the interaction effects with students’ approaches to learning and cognition. The results of a student post treatment questionnaire with supportive interview and observational data are also reported. The chapter concludes with a discussion of the results in relation the research findings and questions.

DESCRIPTIVE STATISTICS

Descriptive statistics are shown in Table 4.1 for the independent variables of learning outcomes (ZLEARN), style and structure (STYLE), information sources (INFO), presentation (PRES) and quality of argument (Q of A). These measures have all been standardised by developing z scores.

Table 4.1: Descriptive statistics for the independent variables with the treatment and non-treatment groups

<table>
<thead>
<tr>
<th>Descriptive Statistics</th>
<th>ZLEARN</th>
<th>STYLE</th>
<th>INFO</th>
<th>PRES</th>
<th>Q OF A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>-.510</td>
<td>4.000</td>
<td>4.000</td>
<td>1.700</td>
<td>4.300</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>1.377</td>
<td>1.124</td>
<td>1.076</td>
<td>.470</td>
<td>2.130</td>
</tr>
<tr>
<td>Std. Error</td>
<td>.308</td>
<td>.251</td>
<td>.241</td>
<td>.105</td>
<td>.476</td>
</tr>
<tr>
<td>Count</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Minimum</td>
<td>-4.226</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Maximum</td>
<td>1.363</td>
<td>5.000</td>
<td>5.000</td>
<td>2.000</td>
<td>8.000</td>
</tr>
<tr>
<td># Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Experimental group

Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>ZLEARN</th>
<th>STYLE</th>
<th>INFO</th>
<th>PRES</th>
<th>Q.OF A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>.221</td>
<td>4.738</td>
<td>4.619</td>
<td>1.810</td>
<td>4.738</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>.654</td>
<td>.627</td>
<td>.661</td>
<td>.397</td>
<td>1.149</td>
</tr>
<tr>
<td>Std. Error</td>
<td>.101</td>
<td>.097</td>
<td>.102</td>
<td>.061</td>
<td>.177</td>
</tr>
<tr>
<td>Count</td>
<td>42</td>
<td>42</td>
<td>42</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Minimum</td>
<td>-1.552</td>
<td>2.000</td>
<td>3.000</td>
<td>1.000</td>
<td>2.000</td>
</tr>
<tr>
<td>Maximum</td>
<td>1.140</td>
<td>5.000</td>
<td>5.000</td>
<td>2.000</td>
<td>8.000</td>
</tr>
<tr>
<td># Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

APPROACHES TO LEARNING

As already discussed in chapter three, each student’s profile, as measured by LPQ, represents the general orientation towards learning or learning style.

Discussions with Biggs (Personal communication, 1998) lead to the notion that the published norms for learning approaches are now dated, but the raw data is still indicative of the student learning approaches. Analyses based on the full range of categories resulted in cell sizes (Table 4.2 LPQ/Uncoded) that were too small to develop a conclusion as discussed in chapter three.
Table 4.2: Frequency distribution and cell size for LPQ

<table>
<thead>
<tr>
<th>Category</th>
<th>C</th>
<th>E</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Achieving</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Surface Achieving</td>
<td>5</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Surface</td>
<td>3</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Low Achieving</td>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>42</td>
<td>62</td>
</tr>
</tbody>
</table>

The data was then aggregated into two categories of Deep and Achieving and Surface and Low Achieving (LPQ/Modified) to represent LPQ in Table 4.3.

Table 4.3: Frequency distribution and cell size for LPQ/Modified

<table>
<thead>
<tr>
<th>LPQ/Mod</th>
<th>C</th>
<th>E</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep &amp; Achieving</td>
<td>9</td>
<td>20</td>
<td>29</td>
</tr>
<tr>
<td>Surface &amp; Low Achieving</td>
<td>11</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>42</td>
<td>62</td>
</tr>
</tbody>
</table>

Data for the Group Embedded Figures Test was aggregated into two categories of Field Dependent and Field Independent in Table 4.4.

Table 4.4: Frequency distribution and cell size for GEFT

<table>
<thead>
<tr>
<th>Category</th>
<th>C</th>
<th>E</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>4</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>FI</td>
<td>16</td>
<td>31</td>
<td>47</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>42</td>
<td>62</td>
</tr>
</tbody>
</table>
INVESTIGATION OF HYPOTHESES

Interpretation of the results for template use and approaches to learning required one analysis with each of the dependent measures. The first analysis consisted of a main effect with the treatment and the LPQ, then the interaction effects for the LPQ and treatment. The analysis was repeated with main and interaction effects of the GEFT.

The hypotheses on template use were divided into five separate sections. The first section addressed (H1.1) learning outcomes. The other sections addressed (H2.1) style and structure, (H3.1) information sources, (H4.1) presentation and (H5.1) quality of argument.

To investigate and test the hypotheses and interactions, data were obtained from:

- the investigation result (Learning Outcomes - ZLEARN) and dependent variables consisting of five sections, i.e. learning outcomes, style and structure, choice of information, presentation and quality of argument;

- learning process questionnaire (LPQ) (independent variable), given to students before the use of the treatment; and

- students' Field Dependence/Independence (GEFT) (independent variable), given to students before the use of the treatment.

A two factor analysis of variance was used to test the hypotheses. Learning outcomes were measured through a composite score of style and structure, information sources, presentation and quality of argument. As a composite score learning outcomes needed to be represented as a standardised deviation from the mean, this was
calculated using a z-score to give the standard score of learning outcomes which then became ZLEARN.

LEARNING OUTCOMES

Main effect with template

H1:1 Students who use the genre templates will score higher on learning outcome measures than students who do not.

To investigate hypothesis 1.1 data were obtained from the student investigation results section 1. learning outcomes (ZLEARN) measure. A two factor analysis of variance was used to test the hypothesis and the results are summarised in Table 4.5.

Students in the experimental group who used the genre template did obtain a significantly higher mean score on learning outcomes (Mean=.221) compared with those students in the control group (Mean=-.510) who did not use the genre template. The null hypothesis was rejected for learning outcomes (F=9.178, df=1.58, p=.0037). Thus the genre templates improved the learning outcomes of students.

Table 4.5: A two factor analysis of variance of learning outcomes and template use

<table>
<thead>
<tr>
<th>ANOVA Table for ZLEARN</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPOQ M</td>
<td>1</td>
<td>.459</td>
<td>.459</td>
<td>.526</td>
<td>.4711</td>
</tr>
<tr>
<td>GPsn</td>
<td>1</td>
<td>7.998</td>
<td>7.998</td>
<td>9.178</td>
<td>.0037</td>
</tr>
<tr>
<td>LPOQ M x GPsn</td>
<td>1</td>
<td>3.031</td>
<td>3.031</td>
<td>3.478</td>
<td>.0672</td>
</tr>
<tr>
<td>Residual</td>
<td>58</td>
<td>50.541</td>
<td>.871</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Main effect with LPQ

H1:2 Students who are Deep and Achieving learners with access to the genre template will score higher on learning outcome measures than students who are Surface and Low Achieving learners.

As shown in Table 4.6, students who preferred Deep and Achieving approaches to learning did not obtain a significantly higher mean on learning outcomes (Mean=-.014) than those students who preferred Surface and Low Achieving approaches to learning (Mean=-.016). The null hypothesis was not rejected for learning outcomes (F=.526, df=1,58, p=.4711). Thus there were no differences in learning outcomes between Deep and Achieving students and Surface and Low Achieving students.
Table 4.6: A two factor analysis of variance of learning outcomes and LPQ

Means Table for ZLEARN  
Effect: LPQ/M

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEEP &amp; ACHIEVING</td>
<td>29</td>
<td>-.014</td>
<td>1.225</td>
<td>.227</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>33</td>
<td>-0.016</td>
<td>.767</td>
<td>.133</td>
</tr>
</tbody>
</table>

Interaction effects with LPQ and group

The interaction effects for LPQ/Modified and treatment gave a probability of p=.0672 in Table 4.5 indicating an interaction between LPQ and group F=3.478, df=1,58, p=.0672.

Table 4.7: A two factor analysis of variance of LPQ and group

Means Table for ZLEARN  
Effect: LPQ/M x GPsn

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEEP &amp; ACHIEVING, Control</td>
<td>9</td>
<td>-.873</td>
<td>1.805</td>
<td>.602</td>
</tr>
<tr>
<td>DEEP &amp; ACHIEVING, Exp</td>
<td>20</td>
<td>.373</td>
<td>.576</td>
<td>.129</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>11</td>
<td>-.213</td>
<td>.885</td>
<td>.267</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>22</td>
<td>.083</td>
<td>.702</td>
<td>.150</td>
</tr>
</tbody>
</table>
Table 4.7 shows the means table and interaction plot for ZLEARN with LPQ and group. On undertaking tests of differences between the cell means using an unpaired t-test, the results in Table 4.8 show contributions to the interactions.
Table 4.8 Unpaired t-test of interaction effects with zlearn and group

Unpaired t-test for ZLEARN
Grouping Variable: Testing
Hypothesized Difference = 0

<table>
<thead>
<tr>
<th>Mean Diff.</th>
<th>DF</th>
<th>t-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeepCon, DeepExp</td>
<td>-1.246</td>
<td>27</td>
<td>-2.835</td>
</tr>
<tr>
<td>DeepCon, SurfCon</td>
<td>-.659</td>
<td>18</td>
<td>-1.069</td>
</tr>
<tr>
<td>DeepCon, SurfExp</td>
<td>-.956</td>
<td>29</td>
<td>-2.156</td>
</tr>
<tr>
<td>DeepExp, SurfCon</td>
<td>.587</td>
<td>29</td>
<td>2.238</td>
</tr>
<tr>
<td>DeepExp, SurfExp</td>
<td>.290</td>
<td>40</td>
<td>1.455</td>
</tr>
<tr>
<td>SurfCon, SurfExp</td>
<td>-.296</td>
<td>31</td>
<td>-1.049</td>
</tr>
</tbody>
</table>

Group Info for ZLEARN
Grouping Variable: Testing

<table>
<thead>
<tr>
<th>Count</th>
<th>Mean</th>
<th>Variance</th>
<th>Std. Dev.</th>
<th>Std. Err</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeepCon</td>
<td>9</td>
<td>-.873</td>
<td>3.258</td>
<td>1.805</td>
</tr>
<tr>
<td>DeepExp</td>
<td>20</td>
<td>.373</td>
<td>.332</td>
<td>.576</td>
</tr>
<tr>
<td>SurfCon</td>
<td>11</td>
<td>-.213</td>
<td>.783</td>
<td>.885</td>
</tr>
<tr>
<td>SurfExp</td>
<td>22</td>
<td>.083</td>
<td>.493</td>
<td>.702</td>
</tr>
</tbody>
</table>

The data from this analysis informs the following hypotheses:

**H1.3** Deep and Achieving students with access to the genre template scored higher on learning outcome measures than Deep and Achieving students without access to the template.

The null hypotheses was rejected (Mean=-1.246 T=-2.835, df=27, p=.0086).

**H1.4** Deep and Achieving students with access to the genre template will score higher on learning outcome measures than Surface and Low Achieving students without access to the template.

The null hypothesis was rejected (Mean=.587 T=-2.238, df=29, p=.0330).
H1.6 Surface and Low Achieving students with access to the genre template will score higher on learning outcome measures than Deep and Achieving students without access to the template.

The null hypothesis was rejected (Mean=-.956 T=-2.156, df=29, p=.0395).

Main effect with GEFT

H1.9 Students who use the genre templates will score higher on learning outcome measures than students who do not.

This has already been discussed in H1.1. The null hypothesis was rejected for learning outcomes (F=9.178, df=1,58, p=.0037) as shown in Table 4.5.

Interaction effects with GEFT and group

Students who were Field Dependent did not obtain a significantly higher mean on learning outcomes (Mean=-.074) than those students who were Field Independent (Mean=-.004). The null hypothesis was not rejected for learning outcomes (F=.278, df=1,58, p=.5998). Thus there were no differences in learning outcomes between Field Dependent and Field Independent students.

Table 4.9: A two factor analysis of variance of GEFT and group.

<table>
<thead>
<tr>
<th>ANOVA Table for ZLEARN</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEFT</td>
<td>1</td>
<td>.256</td>
<td>.256</td>
<td>.278</td>
<td>.5998</td>
</tr>
<tr>
<td>GPsn</td>
<td>1</td>
<td>5.639</td>
<td>5.639</td>
<td>6.134</td>
<td>.0162</td>
</tr>
<tr>
<td>GEFT x GPsn</td>
<td>1</td>
<td>.056</td>
<td>.056</td>
<td>.061</td>
<td>.8059</td>
</tr>
<tr>
<td>Residual</td>
<td>58</td>
<td>53.319</td>
<td>.919</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Means Table for ZLEARN

<table>
<thead>
<tr>
<th>Effect: GEFT</th>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>15</td>
<td>-.074</td>
<td>.974</td>
<td>.251</td>
</tr>
<tr>
<td>FI</td>
<td>47</td>
<td>.004</td>
<td>1.016</td>
<td>.148</td>
</tr>
</tbody>
</table>

The null hypotheses that were related to the interaction of GEFT and Treatment were not rejected. There was no interaction effect between the two variables (\(F=.06, \ df=1,58, \ p=.8059\)).

**STYLE**

*Main effect with template*

*H2:1 Students who use the genre templates will score higher on style and structure than students who do not.*

To investigate hypothesis 2.1 data were from the student investigation results section 2. style and structure measure. A two factor analysis of variance was used to test the hypothesis and the results are summarised in Table 4.10.

Students in the experimental group who used the genre template did obtain a significantly higher mean on style and structure (Mean=4.78) than those students in the control group (Mean=4.00) who did not use the genre template. The null hypothesis was rejected for style and structure (\(F=11.536, \ df=1,58, \ p=.0012\)). Thus the genre templates improved the writing style of students.
Table 4.10: A two factor analysis of variance of style

<table>
<thead>
<tr>
<th>ANOVA Table for STYLE</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPO/M</td>
<td>1</td>
<td>.275</td>
<td>.275</td>
<td>.407</td>
<td>.5261</td>
</tr>
<tr>
<td>GPsn</td>
<td>1</td>
<td>7.789</td>
<td>7.789</td>
<td>11.536</td>
<td>.0012</td>
</tr>
<tr>
<td>LPO/M X GPsn</td>
<td>1</td>
<td>.917</td>
<td>.917</td>
<td>1.358</td>
<td>.2487</td>
</tr>
<tr>
<td>Residual</td>
<td>58</td>
<td>39.165</td>
<td>.675</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Means Table for STYLE</th>
<th>Effect: GPsn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>Mean</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>Control</td>
<td>20</td>
</tr>
<tr>
<td>Experimental</td>
<td>42</td>
</tr>
</tbody>
</table>

Interaction Line Plot for STYLE
Effect: GPsn
Error Bars: 95% Confidence Interval
Main effect with LPQ

H2:2 Students who are Deep and Achieving learners with access to the genre template will score higher on style and structure than students who are Surface and Low Achieving learners.

As shown in Table 4.11 students who preferred Deep and Achieving approaches to learning did not obtain a significantly higher mean on style and structure (Mean=4.483) than those students who preferred Surface and Low Achieving approaches to learning (Mean=4.515). The null hypothesis was not rejected for style and structure (F=.407, df=1,58, p=.5261). Thus there were no differences in style and structure between Deep and Achieving students and those who were Surface and Low Achieving students.

Table 4.11: A two factor analysis of variance of style and LPQ

<table>
<thead>
<tr>
<th>Effect: LPQ/M</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEEP &amp; ACHIEVING</td>
<td>4.483</td>
<td>1.056</td>
<td>.196</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>4.515</td>
<td>.712</td>
<td>.124</td>
</tr>
</tbody>
</table>

Interaction effects with LPQ and group

The interaction effects for LPQ/Modified and Treatment were not significant at the .05 level so the null hypothesis was not rejected as shown in Table 4.10.
Table 4.12: A two factor analysis of variance of style, LPQ and group

Means Table for STYLE
Effect: LPQ M x GPs

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEEP &amp; ACHIEVING, Control</td>
<td>9</td>
<td>3.778</td>
<td>1.394</td>
<td>.465</td>
</tr>
<tr>
<td>DEEP &amp; ACHIEVING, Exp</td>
<td>20</td>
<td>4.800</td>
<td>.696</td>
<td>.156</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>11</td>
<td>4.182</td>
<td>.874</td>
<td>.263</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>22</td>
<td>4.682</td>
<td>.568</td>
<td>.121</td>
</tr>
</tbody>
</table>

Fisher's PLSD for STYLE
Effect: GPs
Significance Level: 5 %

<table>
<thead>
<tr>
<th>Mean Diff.</th>
<th>Crit. Diff</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control, Experimental</td>
<td>-.738</td>
<td>.447</td>
</tr>
</tbody>
</table>

Interaction Line Plot for STYLE
Effect: LPQ M x GPs
Error Bars: 95% Confidence Interval

Table 4.12 shows the means table and interaction plot for style with LPQ and group. The interaction hypotheses were not rejected for style (F=1.358, df1,58, p=.2487) as shown in Table 4.10.
Main effect with GEFT

H2.9 Students who use the genre templates will score higher on style and structure than students who do not.

This has already been discussed in H2.1. The null hypothesis was rejected for style and structure (F=11.536, df=1,58, p=.0012) as shown in Table 4.10.

Interaction effects with GEFT and group

Students who were Field Dependent did not obtain a significantly higher mean on style and structure (Mean=4.53) than those students who were Field Independent (Mean=4.48). The null hypothesis was not rejected for style and structure (F=.102, df=1,58, p=.750) as shown in Table 4.13. Thus there were no differences in style and structure between Field Dependent and Field Independent students.

Table 4.13: A two factor analysis of variance of GEFT and group

<table>
<thead>
<tr>
<th>ANOVA Table for STYLE</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEFT</td>
<td>1</td>
<td>.070</td>
<td>.070</td>
<td>.102</td>
<td>.7501</td>
</tr>
<tr>
<td>GPsn</td>
<td>1</td>
<td>3.434</td>
<td>3.434</td>
<td>5.022</td>
<td>.0289</td>
</tr>
<tr>
<td>GEFT x GPsn</td>
<td>1</td>
<td>.465</td>
<td>.465</td>
<td>.681</td>
<td>.4127</td>
</tr>
<tr>
<td>Residual</td>
<td>58</td>
<td>39.652</td>
<td>.684</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The null hypotheses that were related to the interaction of GEFT and Treatment were not rejected. There was no interaction effect between the two variables (F=.681, df=1,58, p=.4127) as shown in Table 4.13.

**INFORMATION SOURCES**

*Main effect with template*

*H3:1 Students who use the genre templates will score higher on information sources than students who do not.*

To investigate Hypothesis 3.1 data were from the student investigation results section 3. information sources measure. A two factor analysis of variance was used to test the hypothesis and the results are summarised in Table 4.14.

As shown in Table 4.14, students in the experimental group who used the genre template did obtain a significantly higher mean on information sources (Mean=4.61) than those students in the control group (Mean=4.00) who did not use the genre template. The null hypothesis was rejected for information sources (F=7.939, df=1,58, p=.0066). Thus the genre templates did improve the gathering or choice of information sources of students.
Table 4.14: A two factor analysis of variance of information sources

ANOVA Table for INFORMATION

<table>
<thead>
<tr>
<th>Effect</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPQ/M</td>
<td>1</td>
<td>.401</td>
<td>.401</td>
<td>.602</td>
<td>.4410</td>
</tr>
<tr>
<td>GPsn</td>
<td>1</td>
<td>5.291</td>
<td>5.291</td>
<td>7.939</td>
<td>.0066</td>
</tr>
<tr>
<td>LPQ/M x GPsn</td>
<td>1</td>
<td>.401</td>
<td>.401</td>
<td>.602</td>
<td>.4410</td>
</tr>
<tr>
<td>Residual</td>
<td>58</td>
<td>38.655</td>
<td>.666</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means Table for INFORMATION

Effect: GPsn

<table>
<thead>
<tr>
<th>Effect</th>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>20</td>
<td>4.000</td>
<td>1.076</td>
<td>.241</td>
</tr>
<tr>
<td>Experimental</td>
<td>42</td>
<td>4.619</td>
<td>.661</td>
<td>.102</td>
</tr>
</tbody>
</table>

Interaction Line Plot for INFORMATION

Effect: GPsn

Error Bars: 95% Confidence Interval
Main effect with LPQ

H3:2 Students who are Deep and Achieving learners with access to the genre template will score higher on information sources than students who are Surface and Low Achieving learners.

Students who preferred Deep and Achieving approaches to learning did not obtain a significantly higher mean on information sources (Mean=4.55) than those students who preferred Surface and Low Achieving approaches to learning (Mean=4.30). The null hypothesis was not rejected for information sources (F=.602, df=1,58, p=.4410). Thus there were no differences in information sources between Deep and Achieving students and Surface and Low Achieving students as shown in Table 4.14.

Table 4.15: A two factor analysis of variance of information and LPQ

<table>
<thead>
<tr>
<th>Means Table for INFORMATION</th>
<th>Effect: LPQ/M</th>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEEP &amp; ACHIEVING</td>
<td></td>
<td>29</td>
<td>4.552</td>
<td>.948</td>
<td>.176</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td></td>
<td>33</td>
<td>4.303</td>
<td>.770</td>
<td>.134</td>
</tr>
</tbody>
</table>

Interaction effects with LPQ and group

The interaction effects for LPQ/Modified and Treatment were not significant at the .05 level so the null hypothesis was not rejected in Table 4.16.
Table 4.16: A two factor analysis of variance of information, LPQ and group

Means Table for INFORMATION
Effect: LPQ M x GPs

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEEP &amp; ACHIEVING, Control</td>
<td>9</td>
<td>4.000</td>
<td>1.414</td>
<td>.471</td>
</tr>
<tr>
<td>DEEP &amp; ACHIEVING, Exp</td>
<td>20</td>
<td>4.800</td>
<td>.523</td>
<td>.117</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>11</td>
<td>4.000</td>
<td>.775</td>
<td>.234</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>22</td>
<td>4.455</td>
<td>.739</td>
<td>.157</td>
</tr>
</tbody>
</table>

Fisher's PLSD for INFORMATION
Effect: GPs
Significance Level: 5 %

<table>
<thead>
<tr>
<th>Mean Diff.</th>
<th>Crit. Diff.</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control, Experimental</td>
<td>-.619</td>
<td>.444</td>
</tr>
</tbody>
</table>

Interaction Line Plot for INFORMATION
Effect: LPQ M x GPs
Error Bars: 95% Confidence Interval

Table 4.16 shows the means table and interaction plot for information with LPQ and group. The interaction hypotheses were
not rejected for information sources (F=.602, df=1,58, p=.4410) as shown in Table 4.14.

**Main effect with GEFT**

*H3.9 Students who use the genre templates will score higher on information sources than students who do not.*

This has already been discussed in H3.1. The null hypothesis was rejected for information sources (F=7.939, df=1,58, p=.0066) as shown in Table 4.14.

**Interaction effects with GEFT and group**

Students who were Field Dependent did not obtain a significantly higher mean on information sources (Mean=4.60) than those students who were Field Independent (Mean=4.36). The null hypothesis was not rejected for information sources (F=.712, df=1,58, p=.4023) as shown in Table 4.17. Thus there were no differences in information sources between Field Dependent and Field Independent students.

*Table 4.17: A two factor analysis of variance of GEFT and group*

<table>
<thead>
<tr>
<th>ANOVA Table for INFORMATION</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEFT</td>
<td>1</td>
<td>.484</td>
<td>.484</td>
<td>.712</td>
<td>.4023</td>
</tr>
<tr>
<td>GPsn</td>
<td>1</td>
<td>2.881</td>
<td>2.881</td>
<td>4.240</td>
<td>.0440</td>
</tr>
<tr>
<td>GEFT x GPsn</td>
<td>1</td>
<td>.063</td>
<td>.063</td>
<td>.093</td>
<td>.7616</td>
</tr>
<tr>
<td>Residual</td>
<td>58</td>
<td>39.418</td>
<td>.680</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The null hypotheses that were related to the interaction of GEFT and Treatment were not rejected. There was no interaction effect between the two variables (F=.093, df=1.58, p=.7616) as shown in Table 4.17.

**PRESENTATION**

*Main effect with template*

**H4:1 Students who use the genre templates will score higher on presentation than students who do not.**

To investigate hypothesis 4.1 data were obtained from the student investigation result section 4. presentation measure. A two factor analysis of variance was used to test the hypothesis and the results are summarised in Table 4.18.

Students in the experimental group who used the genre template did not obtain a significantly higher mean on presentation (Mean=1.81) than those students in the control group (Mean=1.70) who did not use the genre template. The null hypothesis was not rejected for presentation (F=1.572, df=1.58, p=.2150). Thus the genre templates did not improve the presentation of students.
Table 4.18: A two factor analysis of variance of presentation and template use

ANOVA Table for PRESENTATION

<table>
<thead>
<tr>
<th>Effect</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPMQ/M</td>
<td>1</td>
<td>.286</td>
<td>.286</td>
<td>1.788</td>
<td>.1864</td>
</tr>
<tr>
<td>GPsn</td>
<td>1</td>
<td>.252</td>
<td>.252</td>
<td>1.572</td>
<td>.2150</td>
</tr>
<tr>
<td>LPQ/M x GPsn</td>
<td>1</td>
<td>1.366</td>
<td>1.366</td>
<td>8.522</td>
<td>.0050</td>
</tr>
<tr>
<td>Residual</td>
<td>58</td>
<td>9.295</td>
<td>.160</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means Table for PRESENTATION

Effect: GPsn

<table>
<thead>
<tr>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>20</td>
<td>1.700</td>
<td>.470</td>
</tr>
<tr>
<td>Experimental</td>
<td>42</td>
<td>1.810</td>
<td>.397</td>
</tr>
</tbody>
</table>

Interaction Line Plot for PRESENTATION

Effect: GPsn

Error Bars: 95% Confidence Interval
Main effect with LPQ

H4:2 Students who are Deep and Achieving learners with access to the genre template will score higher on presentations than students who are Surface and Low Achieving learners.

As shown in Table 4.19, students who preferred Deep and Achieving approaches to learning did not obtain a significantly higher mean on learning outcomes (Mean=1.75) than those students who preferred Surface and Low Achieving approaches to learning (Mean=1.81). The null hypothesis was not rejected for presentation ($F = 1.788$, $df=1, 58$, $p=0.1864$). Thus there were no differences in presentation between Deep and Achieving students and those who were Surface and Low Achieving students.

Table 4.19: A two factor analysis of variance of presentation, LPQ and group

<table>
<thead>
<tr>
<th>Effect: LPQ/M</th>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEEP &amp; ACHIEVING</td>
<td>29</td>
<td>1.759</td>
<td>.435</td>
<td>.081</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>33</td>
<td>1.788</td>
<td>.415</td>
<td>.072</td>
</tr>
</tbody>
</table>

Interaction effects with LPQ and group

The interaction effects for LPQ/Modified and Treatment gave a probability of $p=0.005$ as shown in Table 4.18 indicating an interaction between LPQ and group $F=8.522$, $df=1, 58$, $p=0.0050$. 
Table 4.20: A two factor analysis of variance of LPQ and group

Means Table for PRESENTATION
Effect: LPQ/M X GPs

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEEP &amp; ACHIEVING, Control</td>
<td>9</td>
<td>1.444</td>
<td>.527</td>
<td>.176</td>
</tr>
<tr>
<td>DEEP &amp; ACHIEVING, Exp</td>
<td>20</td>
<td>1.900</td>
<td>.308</td>
<td>.069</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>11</td>
<td>1.909</td>
<td>.302</td>
<td>.091</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>22</td>
<td>1.727</td>
<td>.456</td>
<td>.097</td>
</tr>
</tbody>
</table>

Fisher's PLSD for PRESENTATION
Effect: GPs
Significance Level: 5 %

<table>
<thead>
<tr>
<th></th>
<th>Mean Diff.</th>
<th>Crit. Diff</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control, Experimental</td>
<td>- .110</td>
<td>.218</td>
<td>.3181</td>
</tr>
</tbody>
</table>

Interaction Line Plot for PRESENTATION
Effect: LPQ/M X GPs
Error Bars: 95% Confidence Interval

Table 4.20 shows the means Table and interaction plot for Presentation with LPQ and group. On undertaking tests of
differences between the cell means using and unpaired t-test, the results in Table 4.21 show contributions to the interactions.

Table 4.21: Unpaired t-test of interaction effects with presentation and group

<table>
<thead>
<tr>
<th>Unpaired t-test for PRESENTATION</th>
<th>Hypothesized Difference = 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grouping Variable: Testing</td>
<td></td>
</tr>
<tr>
<td>DeepCon, SurfCon</td>
<td>-0.465</td>
</tr>
<tr>
<td>DeepCon, DeepExp</td>
<td>-0.456</td>
</tr>
<tr>
<td>DeepCon, SurfExp</td>
<td>-0.283</td>
</tr>
<tr>
<td>SurfCon, DeepExp</td>
<td>0.009</td>
</tr>
<tr>
<td>SurfCon, SurfExp</td>
<td>0.182</td>
</tr>
<tr>
<td>DeepExp, SurfExp</td>
<td>0.173</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mean Diff.</th>
<th>DF</th>
<th>t-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.465</td>
<td>18</td>
<td>-2.479</td>
<td>0.0233</td>
</tr>
<tr>
<td>-0.456</td>
<td>27</td>
<td>-2.941</td>
<td>0.0066</td>
</tr>
<tr>
<td>-0.283</td>
<td>29</td>
<td>-1.500</td>
<td>0.1444</td>
</tr>
<tr>
<td>0.009</td>
<td>29</td>
<td>0.079</td>
<td>0.9374</td>
</tr>
<tr>
<td>0.182</td>
<td>31</td>
<td>1.194</td>
<td>0.2416</td>
</tr>
<tr>
<td>0.173</td>
<td>40</td>
<td>1.424</td>
<td>0.1621</td>
</tr>
</tbody>
</table>

Group Info for PRESENTATION

<table>
<thead>
<tr>
<th>Grouping Variable: Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeepCon</td>
</tr>
<tr>
<td>SurfCon</td>
</tr>
<tr>
<td>DeepExp</td>
</tr>
<tr>
<td>SurfExp</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Count</th>
<th>Mean</th>
<th>Variance</th>
<th>Std. Dev.</th>
<th>Std. Err</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeepCon</td>
<td>9</td>
<td>1.444</td>
<td>.278</td>
<td>.527</td>
</tr>
<tr>
<td>SurfCon</td>
<td>11</td>
<td>1.909</td>
<td>.091</td>
<td>.302</td>
</tr>
<tr>
<td>DeepExp</td>
<td>20</td>
<td>1.900</td>
<td>.095</td>
<td>.308</td>
</tr>
<tr>
<td>SurfExp</td>
<td>22</td>
<td>1.727</td>
<td>.208</td>
<td>.456</td>
</tr>
</tbody>
</table>

The data from this analysis informs the following hypotheses:

**H4.4** Deep and Achieving students with access to the genre template will score higher on learning presentation than Surface and Low Achieving students without access to the template.

The null hypothesis was rejected (Mean = -0.465 T=-2.479, df=18, p=.0233).
H4.7 Surface and Low Achieving students without access to the genre template will score higher on presentation measures than Deep and Achieving students without access to the template.

The null hypothesis was rejected (Mean =-.456 T=-2.941, df=27, p=.0066).

Main effect with GEFT

H4.9 Students who use the genre templates will score higher on presentation than students who do not.

This has already been discussed in H4.1. The null hypothesis was not rejected for presentation (F=1.572, df=1,58, p=.2150) as shown in Table 4.18.

Interaction effects with GEFT and group

Students who were Field Dependent did not obtain a significantly higher mean on learning outcomes (Mean=1.66) than those students who were Field Independent (Mean=1.80). The null hypothesis was not rejected for presentation (F=1.676, df=1,58, p=.2006) as shown in Table 4.22. Thus there were no differences in presentation between Field Dependent and Field Independent.
The null hypotheses that were related to the interaction of GEFT and Treatment were not rejected. There was no interaction effect between the two variables (F=.246, df=1,58, p=.6215).

**QUALITY OF ARGUMENT**

**Main effect with template**

*H5.1 Students who use the genre templates will score higher on quality of argument than students who do not.*

To investigate Hypothesis 5.1 data were obtained from the student investigation result section 5. quality of argument measure. A two factor analysis of variance was used to test the hypothesis and the results are summarised in Table 4.23.

Students in the experimental group who used the genre template did not obtain a significantly higher mean on quality of argument (Mean=4.30) than those students in the control group (Mean=4.73) who did not use the genre template. The null hypothesis was not rejected for quality of argument (F=1.198 df=1,58, p=.2782). Thus
the genre templates did not improve the quality of argument of students as shown in Table 4.23.

Table 4.23: A two factor analysis of variance of quality of argument

ANOVA Table for Q OF A

<table>
<thead>
<tr>
<th></th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPQ/M</td>
<td>1</td>
<td>1.712</td>
<td>1.712</td>
<td>.717</td>
<td>.4007</td>
</tr>
<tr>
<td>GPs,</td>
<td>1</td>
<td>2.862</td>
<td>2.862</td>
<td>1.198</td>
<td>.2782</td>
</tr>
<tr>
<td>LPQ/M X GPs,</td>
<td>1</td>
<td>.478</td>
<td>.478</td>
<td>.200</td>
<td>.6561</td>
</tr>
<tr>
<td>Residual</td>
<td>58</td>
<td>138.550</td>
<td>2.389</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means Table for Q OF A

Effect: GPs,  

<table>
<thead>
<tr>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>20</td>
<td>4.300</td>
<td>2.130</td>
</tr>
<tr>
<td>Experimental</td>
<td>42</td>
<td>4.738</td>
<td>1.149</td>
</tr>
</tbody>
</table>

Interaction Line Plot for Q OF A

Effect: GPs,  

Error Bars: 95% Confidence Interval
Main effect with LPQ

**H5:2 Students who are Deep and Achieving learners with access to the genre template will score higher on quality of argument than students who are Surface and Low Achieving learners.**

Students who preferred Deep and Achieving approaches to learning did not obtain a significantly higher mean on quality of argument (Mean=4.44) than with those students who preferred Surface and Low Achieving approaches to learning. The null hypothesis was not rejected for quality of argument ($F = .717, \text{df}=1,58, p=.4007$). Thus there were no differences in quality of argument between Deep and Achieving students and those who were Surface and Low Achieving as shown in Table 4.23.

**Table 4.24: A two factor analysis of variance of quality of argument and LPQ**

<table>
<thead>
<tr>
<th>Means Table for QOF A</th>
<th>Effect: LPQ/M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
</tr>
<tr>
<td>DEEP &amp; ACHIEVING</td>
<td>29</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>33</td>
</tr>
</tbody>
</table>

Interaction effects with LPQ

The interactions effects for LPQ/Modified and Treatment were significant at the .05 level so the null hypotheses was rejected as shown in Table 4.23.
Table 4.25: A two factor analysis of variance of quality of argument, 
LPQ and group

Means Table for QOF A 
Effect: LPQM x GPsn

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEEP &amp; ACHIEVING, Control</td>
<td>9</td>
<td>4.000</td>
<td>2.598</td>
<td>.866</td>
</tr>
<tr>
<td>DEEP &amp; ACHIEVING, Exp</td>
<td>20</td>
<td>4.650</td>
<td>.988</td>
<td>.221</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>11</td>
<td>4.545</td>
<td>1.753</td>
<td>.529</td>
</tr>
<tr>
<td>SURFACE &amp; LOW ACHIEVING</td>
<td>22</td>
<td>4.818</td>
<td>1.296</td>
<td>.276</td>
</tr>
</tbody>
</table>

Fisher's PLSD for QOF A 
Effect: GPsn 
Significance Level: 5%

<table>
<thead>
<tr>
<th>Mean Diff.</th>
<th>Crit. Diff</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-.438</td>
<td>.841</td>
<td>.3011</td>
</tr>
</tbody>
</table>

Interaction Line Plot for QOF A 
Effect: LPQM x GPsn 
Error Bars: 95% Confidence Interval

Table 4.25 shows the means table and interaction plot for quality of argument with LPQ and group. The interaction hypotheses were not
rejected for quality of argument \( (F=.200, \text{ df}=1.58, p=.6561) \) as shown in Table 4.23.

**Main effect with GEFT**

**H5.9 Students who use the genre templates will score higher on quality of argument than students who do not.**

This has already been discussed in H5.1. The null hypothesis was not rejected for quality of argument \( (F=1.198, \text{ df}=1.58, p=.2782) \) as shown in Table 4.23.

**Interaction effect with GEFT and group**

Students who were Field Dependent did not obtain a significantly higher mean on quality of argument (Mean=4.30) compared with those students who were Field Independent (Mean=4.68). The null hypothesis was not rejected for quality of argument \( (F=1.739, \text{ df}=1.58, p=.1924) \) as shown in Table 4.26. Thus there were no differences in quality of argument between Field Dependent and Field Independent students.
Table 4.26: A two factor analysis of variance of GEFT and group

<table>
<thead>
<tr>
<th></th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEFT</td>
<td>1</td>
<td>4.043</td>
<td>4.043</td>
<td>1.739</td>
<td>.1924</td>
</tr>
<tr>
<td>GPsn</td>
<td>1</td>
<td>6.300</td>
<td>6.300</td>
<td>2.711</td>
<td>.1051</td>
</tr>
<tr>
<td>GEFT x GPsn</td>
<td>1</td>
<td>3.866</td>
<td>3.866</td>
<td>1.663</td>
<td>.2023</td>
</tr>
<tr>
<td>Residual</td>
<td>58</td>
<td>134.805</td>
<td>2.324</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means Table for Q OF A

<table>
<thead>
<tr>
<th>Effect: GEFT</th>
<th>Count</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fd</td>
<td>15</td>
<td>4.333</td>
<td>1.633</td>
<td>.422</td>
</tr>
<tr>
<td>Fl</td>
<td>47</td>
<td>4.681</td>
<td>1.505</td>
<td>.220</td>
</tr>
</tbody>
</table>

The null hypotheses that were related to the interaction of GEFT and Treatment were not rejected. There was no interaction effect between the two variables (F=1.66, df=1,58, p=.2023) as shown in Table 4.26.

INVESTIGATION OF THE QUESTIONNAIRE DATA

The data for each question were obtained from a post treatment student questionnaire given to all students after their investigation results (learning outcomes) were handed into the researcher.

The questionnaire consisted of twenty-six questions. All participants in both experimental and control groups completed the first thirteen questions. The experimental group completed the last thirteen questions only as they pertained to template use.

The Post Treatment Student Questionnaire was based on learning processes about template use, designed by the researcher and tested in the pilot study. The protocol included structured and open-ended questions. Open-ended questions were used to elicit
participants' perceptions and knowledge. Questions ranged from software use to skills and strategies employed with the use/non-use of the treatment. All information gathered in the questionnaire needed to be reviewed so that the researcher could gain further qualitative insights as to whether moderating variables had an effect on the investigation results and in turn on the use of the genre templates themselves. The sample size consisted of sixty two students. The questionnaire was administered to all students directly, after they had completed the treatment, and handed to the researcher on the same day.

Other data sources included post treatment student and teacher interviews with eight collaborating students and three collaborating teachers. The researcher and researcher's assistant gathered observations throughout the conduct of the study. Data sources and protocols were transcribed and coded.

QUESTIONS TO BOTH GROUPS

To gain an in-depth understanding of how students organised their thoughts and key ideas, structured and open-ended questions were asked of students in the experimental and control groups.
Table 4.27: Questions and responses from the post treatment student questionnaire to both groups.

<table>
<thead>
<tr>
<th>Questions 1-9 are for both groups.</th>
<th>Control</th>
<th>Experimental</th>
<th>Total</th>
<th>Respondants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>1. Do you know what a genre template is?</td>
<td>9 (47%)</td>
<td>10 (52%)</td>
<td>34 (85%)</td>
<td>6 (15%)</td>
</tr>
<tr>
<td>2. Did you start with a plan to help you understand the problem to be investigated?</td>
<td>8 (42%)</td>
<td>11 (57%)</td>
<td>19 (47%)</td>
<td>21 (52%)</td>
</tr>
<tr>
<td>5. When investigating a problem did you find that there was too much information or data to be investigated in the time allocated?</td>
<td>12 (63%)</td>
<td>7 (36%)</td>
<td>19 (48%)</td>
<td>20 (51%)</td>
</tr>
<tr>
<td>9. Would you like to have had an extra window between the PDA and Text Tablet, for example a concept map or brainstorming tool to organise information and key themes?</td>
<td>8 (42%)</td>
<td>11 (57%)</td>
<td>22 (56%)</td>
<td>17 (43%)</td>
</tr>
</tbody>
</table>

**Question 1: Do you know what a genre template is?**

Fifty nine students responded to this question, 9 (47%) students from the control group responded with a Yes, that they did know what a genre template was, 10 (52%) students responded with a No that they did not know what a genre template was.

From the experimental group 34 (85%) students responded with a Yes, that they did know what a genre template was, 6 (15%) students responded with a No, that they did not know what a genre template was.

This question was posed to enable the researcher to obtain information about what metacognitive experiences students have had already with scaffolding tools. The student responses indicate that both groups had some metacognitive experiences.
Question 2-Did you start with a plan to help you understand the problem to be investigated?

Fifty nine students responded to this question, 8 (42%) students from the control group responded with a Yes, that when investigating a problem, they did start with a plan, 11 (57%) students responded with a No that they did not start with a plan.

The control group’s comments included: Just to research the problem; I kept reading the question repeatedly until it made perfect sense to me. The next stage was to find as much information related to the problem as possible; Gather any useful information, write article referring to this information and spell check and edit, I asked the helpers at the research centre what to do; I wanted to learn programs then, collect all relevant information, then have a main message statement and then write; Search for sources until a good understanding is acquired; I decided to obtain as many facts as possible first then collate them, decide how they were relevant, and used them to help me assess the problem; and I rather had a plan by just organising what I wanted where I wanted.

From the experimental group 19 (47%) students responded with a Yes, that when investigating a problem, they did start with a plan, 21 (52%) students responded with a No that they did not start with a plan.

The experimental group’s comments suggested that they: planned to sort through the information, structure it and then write my report; Explore program and tools look at all the reports/articles to gather information, test water and used blue green algae simulation write report; I used the discussion genre template to see what the question was asking and then sorted through all my notes to find
relevant information; I collected information on the dam then highlighted if it was for or against then used the discussion genre to write it; I looked at the Discussion template then got my information in my PDA notes. Worked out my main points then used the information in my final copy; and I decided to follow the advice of the guy in the research centre and looked through the computer catalogue as well as taking measurements.

Question 5-When investigating a problem did you find that there was too much information or data to be investigated in the time allocated?

Fifty eight students responded to this question, 12 (63%) students from the control group responded with a Yes, that there was too much information or data, 7 (36%) students responded with a No that there was not too much information or data.

From the experimental group 19 (47%) students responded with a Yes, that there was too much information or data, 20 (51%) students responded with a No that there was not too much information or data.

Question 9-Would you like to have had an extra window between the PDA and Text Tablet, for example a concept map or brainstorming tool to organise information and key themes?

Fifty eight responses were gathered and 8 (42%) students from the control group indicated Yes, that they wanted an extra window between the PDA and Text Tablet, for example a concept map or brainstorming tool to organise information and key themes, 11 (57%) students responded with No.

Comments from the control group indicated that: It would help to organise information more and would link the PDA and Text tablet
easier; I did not exactly know how I was going to tackle the problem so a brainstorming tool would have been helpful; This would allow students to brainstorm and show another process clearly; and A place to draft or write out points in full and then put them on the text tablet would be good. The people who indicated No they felt that the two windows make the screen cluttered enough.

Twenty two (56%) students from the experimental group indicated Yes, that they wanted an extra window between the PDA and Text Tablet for example a concept map or brainstorming tool to organise information and key themes and 17 (43%) students responded No.

Comments from the experimental group relating to an extra window or tool for organising information and key themes suggested that: This would help by giving you a chance to sort the relevant information out; Much easier rather than constantly returning to the WRC (water resource centre), A place to brainstorm would be useful; It would make it easier to organise notes and easier to add my own notes; This would be helpful to refer back to a basic plan for the article that would keep me more organised; and This would have helped me to see clearly, where I was and where I was heading in my task all the time. The students who indicated No said that: There are enough windows, and other responses included comments like: I would have liked the PDA to be bigger because I like working in a larger area and being able to see everything at once (so I can compare everything in relation to each other). I also forget which works, what I have used previously if I can’t re-read.

In general, students identified concept mapping as a way to approach a problem to solve. Students’ comments suggest that there seems to be a fine line between wanting an extra window or a tool in organising information; both groups provide justification for
having an extra window or tool and for not. In general, students were concerned about working space, having too many windows open and not being able to hide these windows. This became a problem for some students. Students in general used a combination of both the PDA and text tablet. They felt that these were valuable tools to be used with such a variety and large number of resources.

OPEN-ENDED QUESTIONS TO BOTH GROUPS FROM THE POST TREATMENT STUDENT QUESTIONNAIRE

Question 3-If you did not start with a plan, how did you monitor how you solved the problem?

The control group comments referred to using: hints from the guides, taking measurements from the dam and using the simulator to get the facts; having collected all the relevant information they thought was relevant. After having collected all the information students’ started to write using the information they had found while; keeping the purpose of the task in mind. Students’ monitoring of the problem involved; not beginning with a plan but becoming lost in her/his ideas.

Comments from the students in the experimental group referred to: taking one step at a time; I got help from the program and worked through the task; I Just thought about it and referred to the discussion genre; and I read through my writing to check that it was going ok.

Students in both groups had different ways of monitoring how they solved the problem. Students in the control group appeared to be looking for additional help, for example, by using guides and
students in the experimental group used their own applied structures and read over their work.

Question 4-How did you organise your thoughts and key ideas?

a. Which techniques worked? and

b. Which techniques didn’t work?

Responses from students in the control group were of a mixed variety. These included: Putting them on paper; Analyse the possibilities in my mind and build a pathway or link the issues mentioned in my assignment; Taking constant notes and sometimes writing sentences and paragraphs on the Text Tablet as I thought of them. Responses from students included: thought processes being jumbled and confused at the best of times; organising thoughts only in my head and on a brainstorm; In order of finding the information on the program; and using different text colours to coordinate the information. Other students within this group did specify using linear and logical formations, for example: In point form under different headings; and I organised them how I believed they would be best suited to explaining my point of opinion on the subject.

With regard to techniques that worked for them students thought that colour coding techniques, not knowing how they did it, using the PDA and cutting and pasting articles and resources worked for them. Students in this group found the techniques that did not work for them and answers included: Collecting information and typing it out in to PDA is a big jumble; having to adjust their techniques as they gathered or came across more information; Trying to write information for the article without taking notes; and Trying to remember the points. This suggested that students did or could benefit from use of the discussion
template as a cognitive tool to help organise and extend students planning processes when organising information.

Comments from the students in the experimental group all referred to organising their thoughts and key ideas with reference to the discussion template: I put them under headings suggested in my genre template. Students referred to the headings suggested by the genre template, using the text tablet with the discussion template in it and following the structure of the discussion template with arguments for and against. In recommending which techniques worked for the experimental group, the students felt that organising their thoughts and key ideas under categories and areas in relation to the discussion template was the preferred process. When asked which techniques didn’t work the following statement, Attempting to write the article just by reading through a lot of information provides evidence for the notion that students in the experimental group preferred to use the discussion template to organise thoughts and key ideas.

Question 6- Did you use the PDA or the Text Tablet to organise your information?

Students used a variety of cognitive tools within the CD-ROM Exploring the Nardoo to organise information that was presented in multiple modalities. Two of these included the PDA (Personal Digital Assistant) and the TT (Text Tablet a large clear writing space); both had editing facilities attached.
Table 4.28: Post treatment student questionnaire responses

<table>
<thead>
<tr>
<th>Question</th>
<th>Control</th>
<th>Experimental</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you use the PDA or the Text Tablet to organise your information?</td>
<td>PDA</td>
<td>TT</td>
<td>Both</td>
</tr>
<tr>
<td>a) PDA</td>
<td>5</td>
<td>0</td>
<td>14 (73%)</td>
</tr>
<tr>
<td>b) Text Tablet</td>
<td>14 (26%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>c) Both</td>
<td>14 (73%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PDA</td>
<td>TT</td>
<td>Both</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>2</td>
<td>31 (79%)</td>
</tr>
<tr>
<td></td>
<td>(15%)</td>
<td>(5%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fifty eight students responded to this question, 5 (26%) students from the control group used the PDA only, no students used the Text Tablet and 14 (73%) students used both the PDA and Text Tablet.

The control group felt that using both was an advantage in organising information: It was good because I knew what was where; It was great to be able to use both the PDA and text tablet. Having the two of them saved a great deal of confusion; and I grabbed information-linked media and put it in the PDA then rewrote it in notes on the Text Tablet then typed the article in the PDA.

From the experimental group 6 (15%) students from the control group used the PDA only, 2 (5%) students used the Text Tablet and 31 (79%) students used both the PDA and Text Tablet.

The experimental group commented on the use of the PDA and TT: I put my information on the PDA and presented on my text tablet; I put relevant information in the PDA discarded anything I didn’t need and from there I used the text tablet; I used the PDA to store notes throughout the program and I used the text tablet to write my notes, drafts and final copy because it was larger.
Question 7-Did you rate your evidence from most important to least important while solving the problem?

Comments from the control group included: nobody told me to; why bother; I gathered the information without reading it, as I worked into the text tablet I read it; I did not rate it, it was all important; I categorised the information depending on the amount of information rather than the importance; and I was unorganised because of the lack of time allocated x3.

Students’ from the experimental group mentioned: putting the most important points first; stating the main arguments and grouping evidence into disadvantages and advantages; and that they rated their evidence because they found; some of the information were biased editorials, in which they disregarded.

Question 8- How would you normally approach a problem to solve?

Table 4.29: Post treatment student questionnaire responses

<table>
<thead>
<tr>
<th>Question</th>
<th>Control</th>
<th>Experimental</th>
<th>Respon-ses</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM</td>
<td>LS</td>
<td>NLS</td>
<td>CM</td>
</tr>
<tr>
<td>8. How would you normally approach a problem to solve? Would you use a) Concept map b) Linear structure c) Non Linear structure?</td>
<td>5 (5%)</td>
<td>3 (3%)</td>
<td>2 (2%)</td>
</tr>
</tbody>
</table>

37 students responded to this question, 5 (5%) students from the control group indicated that they approached a problem to solve by using a Concept map, 3 (3%) students used a Linear structure, 2 (2%) students used a Non linear structure.

Students in the control group felt that a concept map was a good way to solve problems because it incorporates any idea that may be useful or topic related. With reference to a linear structure students would
approach a problem by going from; the most important to the least important; and using a Non Linear structure in the following way: I did some brainstorming and adapted my ideas as the problems arose mostly in my head.

Students in the control group preferred to use a concept map in their approach to organising information for problem solving even though one was not provided.

From the experimental group 11 (40%) students indicated that they approached a problem to solve by using a Concept map, 9 (22%) students used a Linear structure, 6 (15%) students used a Non linear structure.

Students in the experimental group approached a problem using a concept map because they felt that: This seems the easiest to use; I would use a mind map type structure to set out ideas so I can easily remember information and ideas that I had previously thought of; I like to arrange my ideas so I can see them clearly. I can then see the ideas and headings I need to expand on these; and This is easier for me to solve problems. Others used a Linear structure to approach a problem: I like to have things organised in a systematic way under headings etc, so I can easily sort through it. The experimental group who used a Non Linear structure felt that this was due to the following reasons: Random thoughts are usually the ones at the back of the brain, which filters things better; I get an idea and stick with it if it works; and I get as much information as possible on every possible related topic then structure it/pick and choose.

Students in both groups discussed concept mapping, linear and non linear structures, brainstorming, researching ideas, looking for links or expanding from sub headings as a way of approaching a problem being
investigated. Students were aware of concept mapping, a linear structure and non linear structure as they had had experience working with different knowledge structures in their junior years. However there were only 37 responses so some students may have not understood the question.

*Question 10-What was your single, most important difficulty in solving the problem?*

The students in the control group who did not have use of the discussion template indicated that their main difficulty was: organising and ordering the information into the article; to get the important information from all the other information; and being able to understand information and connect it together.

Students' comments showed that they had many difficulties in solving the problem. The students in the experimental group, who had the use of the discussion template available to them, still had some concerns about how to organise diverse information: organising all the different quotes and sources I had then deciding which argument was stronger. However, these concerns were minor for the experimental group compared to other stated difficulties such as being worried about the time limit, working with computer tools, using the computer for everything and completing the conclusion. Some students in both groups stated that time was a main difficulty in organising diverse information, however, the time frame used for the completion of this task was considered by the teachers and most students as adequate.
Question 11-Did you start by looking at the overall problem or did you immediately break down the problem into smaller parts?

Comments from students suggested that the majority of the students in the control group started by looking at the overall problem, I looked at the overall problem (students x8) and I looked at the overall problem and then as I scanned further I looked at the information and then broke it down (students x6).

Evidence from the experimental group indicated that half of the group started by looking at the overall problem: I looked at the overall problem and started breaking the problem down (students x9), Overall problem (students x11); I looked at the overall problem, then as I went along I slowly broke it down and I looked at the overall problem read all relevant information and then broke the information into categories, I always referred back to the question. The rest started by breaking the problem down into smaller parts. A statistical analysis provides further evidence for learning outcomes on what type of approaches were taken by students in the treatment and non-treatment groups.

Question 12-What would you do differently if you had more time and resources to work on the problem?

The control group’s comments, indicated that students wanted more time for planning. For example: I would include more information that was more relevant to the problem and spend more time concentrating on what I was conveying (students x5); and Made drafts and edited properly. Took more time to collect ideas and information. These comments support the reference to the narrow margin between too much information and the amount of data being investigated in the time allowed. Thus it seems that the use of
the genre template reduced the perceived need for more time to resolve the problem.

In the experimental group most students suggested that they would not be doing anything different. For example: No, I think we had sufficient time to do it and I was able to do it fairly thoroughly; Nothing I had plenty of time; No this is my way of doing things; Nothing I was relatively happy with my work (students x2). Some students wanted more time to plan how to write. For example; Would have spent more time planning how to write and organise my task rather than planning what to write, would only have grabbed relevant sentences into my PDA rather than huge slabs of information. Other students in the experimental group would have liked more time to learn the information well. For example: I would take more time to learn instead of summarising what was relevant in the program; and More structure and better presentation (students x3).

*Question 13-Did you feel pressure to try and complete the problem?*

Responses from the control group included: I felt pressure but finished it easily within the time allocated (students x2); and the only reason I felt pressured to complete the problem was because I missed three periods. I strived to finish the problem at the same time as my other classmates who had been to every lesson and succeeded to after much concern. This research assignment has meant a great deal to me and I have found it extremely rewarding and my computer skills have improved out of sight.

The experimental groups' comments included: I felt no pressure it was merely just another task; there was enough time and more than enough information so there was really no pressure; It was being assessed, it
was important; sometimes I took too much time browsing through the program.

Students' in both groups were at times concerned with: feeling pressure to complete the problem within the time frame allocated; while other students did not mind the pressure. Variables such as; using the computer tools, experience with computer skills, being assessed and students' pacing themselves in synthesising a report all related to students concerns about feeling pressure to complete the task.

**QUESTIONS TO THE EXPERIMENTAL GROUP**

*Table 4.30: Questions from the post treatment student questionnaire to the experimental group.*

<table>
<thead>
<tr>
<th>Questions 14-24</th>
<th>Experimental</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. Was it easy to initially find the Discussion template?</td>
<td>Yes 31 (79%)</td>
<td>No 8 (20%)</td>
</tr>
<tr>
<td>18. Did you know how to organise your information without using the Discussion template?</td>
<td>Yes 25 (65%)</td>
<td>No 13 (34%)</td>
</tr>
<tr>
<td>19. Did you use the PDA to store information, before using the Discussion template?</td>
<td>Yes 35 (92%)</td>
<td>No 3 (7%)</td>
</tr>
<tr>
<td>20. Did you use the structure of the Discussion template? (i.e. Introduction, three arguments for and against and conclusion)?</td>
<td>Yes 33 (86%)</td>
<td>No 5 (13%)</td>
</tr>
<tr>
<td>21. Did you keep the structure from the Discussion template while constructing your answer?</td>
<td>Yes 32 (86%)</td>
<td>No 5 (13%)</td>
</tr>
<tr>
<td>23. Do you think that the template helped to remind you of how to organise your thoughts, knowledge and information?</td>
<td>Yes 30 (88%)</td>
<td>No 4 (11%)</td>
</tr>
<tr>
<td>24. Did you feel the interactions with the Discussion template enabled you to learn more about the problem?</td>
<td>Yes 22 (66%)</td>
<td>No 11 (33%)</td>
</tr>
</tbody>
</table>

**Question 14-Was it easy to initially find the Discussion template?**

Thirty nine students responded to this question, 31 (79%) students responded with Yes they felt that the discussion template was easy to find, 8 (20%) students responded with No that it was not easy to. From responses in Table 4.30 it appears that 31 (79%) students did
not have a problem in finding the template. The students who thought that the template was easy to find stated that: it was very self explanatory and easy to understand; I knew it had to be a discussion because the word discussion was used in the task explanation; It was easy to find because I explored all aspects of the program before beginning; and I immediately looked in the genre book to see what I had to do, it was right there. Of the 8 (20%) students who did have a problem in finding the information this may have been because their computer literacy skills were deficient or that they had not properly explored the package before starting the task, nor paid attention in the orientation session given to all students in the experimental group.

Question 18-Did you know how to organise your information without using the Discussion template?

Thirty eight students responded to this question, 25 (65%) students responded with Yes, that they knew how to organise their information without using the Discussion template. 13 (34%) students responded with No, that they did not know how to organise their information.

Comments from the students who said that they knew how to organise their information without using the discussion template indicated that they still used it anyway. The students felt that it was: merely a guide; similar to an essay but less formal and gave more scope for flexibility; had some ideas but the template provided and already organised option; I am naturally organisational; and It's something we learned in English. The students who did not know how to organise their information without the template found it useful as; a starting point; a way of correctly organising information; structuring the article; and, as two
students put it: I didn’t know what to do without the template and I was taking so much information I didn’t know where to start. In this case the students felt that the discussion template had helped them to make sense out of diverse information.

From the comments, many students used the PDA first and then used the Text Tablet to write the final article and organise information, although they thought that the PDA and Text Tablet both had their limitations. To pursue this issue further, students in the experimental group were then asked, Did you use the PDA to store information, before using the Discussion template?

Question 19-Did you use the PDA to store information, before using the Discussion template?

Thirty eight students responded to this question, 35 (92%) students indicated Yes, that they did use the PDA to store information before using the discussion template, 3 (7%) students answered with No.

This would be a logical process for students’ as the PDA was the first working space that most students came upon during exploration of the software package.

Question 20-Did you use the structure of the Discussion template (i.e. Introduction, three arguments for and against and conclusion)?

Thirty eight students responded to this question, 33 (86%) students indicated Yes, that they did use the PDA to store information before using the discussion template, 5 (13%) students answered with No.

The responses show that most students’ in the experimental group used the discussion template as a way of structuring their reports. This was the appropriate structure to choose in completing the task.
Question 21-Did you keep the structure from the Discussion template while constructing your answer?

Thirty seven students responded to this question, 32 (86%) students said Yes, that they did keep the structure of the discussion template, 5 (13%) said No they did not.

Students who indicated No, were asked what structure they used or how they used the Discussion template? Answers included: I structured it like the template but had more arguments; I used it at the end when presenting; I followed the general genre; and I used a kind of chaotic but orderly structure. Their comments indicated a manipulation of the existing genre template. The five students who said that they did not use the structure and used some other form, still referred to using a structure of the genre template similar to the discussion template to organise their information.

Evidence so far indicated that students used the discussion template in a variety of ways for a variety of reasons. The majority of users needed a starting point to organise information. To further clarify this issue students were asked if they thought that the template helped to remind them of how to organise their thoughts, knowledge and information.

Question 23-Do you think that the template helped to remind you of how to organise your thoughts, knowledge and information?

Thirty four students responded to this question, 30 (83%) students believed: that the discussion template did help to remind them of how to organise their thoughts knowledge and information; whereas 4 (11%) students answered No and 8 students chose not to respond to this question.
Students felt that the discussion template gave them a structure that provided hints as to how they should be organising their thoughts and knowledge while gathering their information.

**Question 24-Did the interactions with the Discussion template enable you to learn more about the problem?**

Thirty three students responded to this question, 22(66%) students felt the interactions did enable them to learn more about the problem. It is also interesting to note that 11(33%) of students answered No.

Some students felt that the interactions with the discussion template gave them a chance to learn more about the problem, while others felt the interactions gave them no help at all.

**OPEN-ENDED QUESTIONS FROM THE EXPERIMENTAL GROUP**

**Question 22-If you started with the structure from the Discussion template and disregarded this structure from the Discussion template at a certain point while completing your task, please explain at what point you disregarded the discussion template structure?**

Answers included: I Just had more arguments; Once I had the set out of my article under control, I only had to check the template occasionally to make sure that I was on the right track; I stuck to the template; When I began to write the final copy; In the middle of the task and When I had all my information together and was ready to finish up.

From student comments above the genre template supported students as a structure and guide. Students disregarded this structure when they were finished writing their responses to the task.
Question 15 - At what stage did you choose to use the Discussion template?

Twenty two of the students from the experimental group stated that the template did help them in their learning process. It is vital to understand at what stage of their learning this did occur.

Table 4.31: Post treatment student questionnaire responses

<table>
<thead>
<tr>
<th>Question</th>
<th>Begin</th>
<th>End</th>
<th>Other</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. At what stage did you choose to use the Discussion template?</td>
<td>22 (58%)</td>
<td>2 (5%)</td>
<td>14 (36%)</td>
<td>38</td>
</tr>
</tbody>
</table>

Twenty two (58%) students said Yes, that they used the template at the Beginning, 2 (5%) students used the discussion template at the End, 14 (36%) indicated Other. Students were given a choice of Other because they may have used the Discussion template in a variety of ways not yet identified by the researcher or at different times than the ones suggested by the research questionnaire. Even though students were provided with the opportunity to comment on other ways they did not.

Question 16 - If you chose to use the Discussion template, why did you prefer to use it?

To further establish how the template helped the students to organise information the next question in Table 4.32 asked,

Table 4.32: Post treatment student questionnaire responses

<table>
<thead>
<tr>
<th>Question</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>16. If you chose to use the Discussion template, why did you prefer to use it? a) I was not comfortable with organising information b) I knew how to organise information c) I needed a starting point</td>
<td>4 (11%)</td>
<td>6 (17%)</td>
<td>21 (60%)</td>
<td>38</td>
</tr>
</tbody>
</table>

Thirty eight students responded to this question, 4 (11%) students where not comfortable with organising information, whereas 6
(17%) students said they chose to use the genre template because they knew how to organise their information and 21 (60%) students said that they needed a starting point. Students’ comments suggested: It helped me to organise my thoughts and information clearly; I used it for my final presentation; It gave my article direction so I knew where I was going; It looked easier to use; and I didn’t exactly use it, I only used it as a guide.

Question 17-Did you look at the information presented in the presentation guide on the Discussion template to structure information and use this or use your own information structure?

Table 4.33: Post treatment student questionnaire responses

<table>
<thead>
<tr>
<th>Question</th>
<th>Discuss/Template</th>
<th>Used own</th>
<th>Used Both</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. Did you look at the information presented in the presentation guide on the Discussion template to structure information and use this or use your own information structure? a) Discussion template b) Used own information structure c) Used Both</td>
<td>16 (43%)</td>
<td>5 (14%)</td>
<td>16 (43%)</td>
<td>37</td>
</tr>
</tbody>
</table>

There were 37 responses to this question; 16 (43%) students indicated that they Used the discussion template when investigating a problem, 5 (14%) students stated that they Used their own information structure, 16 (43%) students indicated that they Used both and 5 students chose not to respond to this question. When students were asked how they used their own information structure a typical learner response was: I used the discussion template to see how to write the article but disregarded the subheadings they suggested. A summary of the above comments by the students indicates that those who used their own information structure still referred to either using the discussion template or a combination of their own information structures and the discussion template.
RESULTS AND SUMMARY OF THE
QUESTIONNAIRE DATA

1. Data from the questionnaire revealed that students believed that the genre templates as a cognitive tool helped them to make sense out of diverse information by providing a starting point, a way of correctly organising information, and a way of structuring an article that reduces cognitive load. The genre template allowed students to scaffold their learning about the problem. The control group’s greatest difficulty was in organising the diverse information and being able to understand information and make connections to synthesise a response to the problem. The experimental group used the genre template as a method for planning the organisation of diverse information while identifying the most appropriate answer.

2. Evidence from the questionnaire revealed that the discussion template helped the students organise information because students found that the discussion template was easy to find: It was very self explanatory and easy to understand. Students chose and preferred to use the discussion template because they already knew how to organise their information as they had been taught in other subjects about genre. Some students were not comfortable in organising their information, the majority of students needed a starting point and several students found that it gave their article direction so they knew where they were going and; It helped them to organise their thoughts and information clearly.

3. Generally, students kept the structure of the discussion template when organising their information. Although students stated that they already knew how to organise information without using the discussion template, they still preferred to use it. The genre template also alerted students to look at both positive and negative
aspects of an argument. The students that did not keep the structure still referred to using the genre template. Students in general thought that the discussion template reminded them of how to organise their thoughts, knowledge and information.

When asked directly how they organised their key ideas and thoughts, the students in the experimental group all referred to organising their key ideas and thoughts under categories and the discussion template. The control group referred to a variety of mixed methods when organising their thoughts and key ideas. The techniques they felt that worked were colour coding and making lists. Techniques that they felt did not work in helping them to organise their key ideas were trying to remember points and having to adjust techniques as they gathered or came across information. The experimental group, compared with the control group, felt that the genre templates helped them to organise information while completing the task.

The majority of students in the experimental group used a combination of both the discussion template and their own information structures to organise the information. Students were concerned with the ordering of information into their article and being able to understand information while synthesising it.

Over half of the students chose to use the discussion template at the beginning of the task while two students used it at the end. Another student stated specifically that s(he) used the template in the middle of the investigation. Students from the experimental group thought that it was easier to use what was there, rather than design their own format. Others kept the genre template structure while constructing their answer.
Students in the experimental group started with a plan. The plan included using the genre templates to help them understand the problem. When students clicked on a guide, they provided suggestions for planning and completing a task. One of these suggestions was to use a genre template. As a consequence, evidence from the questionnaire revealed that students in the experimental group started to approach a problem by looking at both the overall problem and by breaking the problem down into smaller parts. This was consistent with following the scaffolding structure of the templates. By contrast the control group approached a problem only by looking at the overall problem. However students in the experimental group did refer to using the genre template and when asked what their plan was the experimental group referred to the discussion template.

4. In the experimental group, the questionnaire data revealed that half of the students felt that the interaction with the discussion template did enable them to learn more about the problem. These students also used the discussion template at the beginning of the task. This also provides evidence for the notion that students used the genre template as part of their planning process.

5. Another tool needed for support in organising information was concept mapping. Students in the treatment group were not clear as to where this could be included in the program. Half of the students felt that they wanted it between the PDA and the Text Tablet and the other half did not want to include any extra tools. Students did, however, make other suggestions that could be incorporated as tools, for example, feedback in the form of reward certificates, better help facilities and interactions with their answers or responses to investigations.
This suggests to the stakeholders that students need to know how they are progressing during the completion of a task where they have to gather large amounts of resources and information in synthesising a response. Students reportedly wanted more interaction with the tools, guides and hints. They wanted to interact with the package as in a virtual environment and see the results of their work. The suggestions for other tools should take the format of planning and reflection tools. These tools need to be identified, developed and refined by the stakeholders for the organisation of information that is presented in multiple modalities for representation. Students were concerned with time, resources, planning and writing the final article. Students and teachers wanted easy access to all information without having to view the specific information itself. They did not want pop up buttons with labels of identification for objects on them, but a pictorial representation of the objects themselves. They also requested facilities for the tabulation of the vast resources and information that were gathered by students while investigating a problem and completing a task. A means of evaluation of student responses was also requested by teachers for use by future designers of interactive multimedia programs.

TEACHER AND STUDENT INTERVIEWS

The interviews were conducted two weeks after the post treatment questionnaire to gain further insights into students' perceptions of treatment use or non-use. The interview questions were open-ended with a focus on how the students organised their information while constructing their solutions to the set task used in the treatment. The following are summarised sections from the transcripts of the post treatment interviews with four students from the experimental and four students from the control group.
Several interview questions were asked by the researcher to students in the experimental group with reference to how students organised their information for a set task. Their responses revealed that students in the experimental group firstly looked for the genre, the one that gives both sides of the story and your opinion. Students then gathered all the different information, put it all together using the Text Tablet as a place to draft their final copy. Several students used the genre template as a sort of a basis. Not like a strict guideline but a basis for what I wrote. I ended up with the actual structure and just kept that. Other students used the PDA to store information, first using the genre template within the PDA structure: I went through all sources and copied them into PDA, read them again, reworded them and put them in to my notes. Students then disregarded the structure after they had reread and reworded their notes. Data from the interviews revealed that students in the experimental group did use the discussion template as a means to structure and organise their information.

Extra information was obtained where the student looked at all the information available, gathered resources and then used a combination of genre templates and further examples of the generic scaffolding provided by the program to make sense out of the diverse information while investigating a task. Students from the control group referred to organising information again using a variety of mixed strategies that included gathering all information in the time limit required and listing relevant information in point form.

The three teachers that were interviewed all mentioned the very important point of having a hardcopy of student work for marking
purposes, instead of only having an electronic copy from student floppy disks:

You needed to be able to have a print-out copy to mark and for the kids to share, that displayed all of the multiple media instead of just the buttons. You could not tell what was what with the pictures and videos.

The teachers expressed the view that the children would not have enough time to realistically present all their information in a class setting; it would take too long to go through all the multimedia presentations. Teachers believed that learning outcomes for the problem-solving task should not involve student presentations of their work during class time. They wanted a hardcopy of student task results to take home and mark in their own time.

Some forms of evaluation, tabulation and a spell check for students were improvements for future designers suggested by teachers. Students asked for: Edit and paste facilities that could be included to make a table, so that you could type in your own measurements; and Knowing of some way to access all of the information without having to open up everything. From the student and teacher interviews, further ideas and suggestions were put forward by students for other tools being included in the package for support in organising information. These included more help facilities, for example, bubbles that only highlighted and did not open up but showed you what it was?; Students also requested games and a reward process, for example:

It would be good to have a certificate that you could get like other games packages. You needed feedback after a while because the program became repetitive, you needed something like Wing Commander Three.
Students felt that it would be better to see their finished work in some sort of interaction process (simulated or virtual) within the program itself, for example:

You could be given an assignment and have to interview another person who would then interact with you and answer your questions or maybe a news presentation (somebody presenting your work on the news);

and

Or you could have a newspaper article in the program with your article or assignment finished in it and you could flick through it and read it with other stuff, or maybe write a report and somebody else interview you and commented on it like a member for Parliament.

Students wanted other tools that they could manipulate in order to see their finished results. They wanted to reflect on their learning processes and outcomes by changing roles. Students felt that:

Everything on the computer was too difficult, I could not put water samples in, I could not put particular pictures that I choose from the fields, for example, cut people's faces and other pictures out from field or media.

Students needed more tools and greater flexibility within the program.

RESULTS AND SUMMARY OF THE OBSERVATION DATA

Direct observations were gathered throughout the study by the researcher and research assistant in the school's computer laboratory. The observations were required to identify any further trends or themes in relation to the use and non-use of the genre templates. They were recorded on a protocol designed by the
researcher and tested in the pilot study. Observations were further gathered using tracking data via the collection of student’s process notes in the PDA.

Analyses of observations from students use of the CD-ROM *Exploring the Nardoo* showed the researcher that students both in the experimental and control groups used several of the cognitive tools within the package such as the PDA, Text Tablet (TT) and the edit and help facilities. Students used these in a variety of ways depending on how they processed the information in synthesising a response to a given task. Observations from the experimental group showed that students looked for the genre template at the beginning of the task. Students (1) collected notes and resources into the PDA, (2) searched for and identified the Discussion template, (3) copied the discussion template on to the Text Tablet (TT) and (4) copied the PDA notes and resources into the appropriate sections of the Discussion template that was contained within the Text Tablet to write their final article. Most students found access to the genre templates via the help facilities or by exploring, discovering and clicking on objects. In summary, observations indicated that students copied the task investigation, used the PDA to collect information, copied the discussion template to the Text Tablet before entering their notes and information. The students then continued copying their notes and information from the PDA to the appropriate sections in the discussion template within the Text Tablet. They then reviewed their notes and information sources to synthesis a response to the task. In contrast the control group mainly accessed the task, copied it into the PDA and continued to complete their task in this area.
RESULTS AND DISCUSSION OF THE RESEARCH QUESTIONS

Each of the five research questions raised will be discussed with reference to the data sources associated with each question. The post treatment student questionnaire was the main data source for reporting on the research questions, supported by the hypothesis testing on template use, approaches to learning and cognition.

1. Do the genre templates assist as a cognitive tool to help students make sense out of diverse information?

The genre templates appeared to assist students as a thinking tool that could be accessed to make sense out of a large and diverse body of information as embedded resources. Data relating to hypothesis one on template use and student learning outcomes, post treatment questionnaire and interviews supported the hypothesis. There was a positive difference in learning outcomes $df=1,58$, $p=.003$, style $df=1,58$, $p=.001$ and choice of information, $df=1,58$, $p=0.006$ between those who used the discussion template and those who did not. Students believed that the use of the genre templates gave them a starting point, structure and scaffold to connect diverse information, presented as multimedia together when synthesising a response to a problem solving task. The experimental group supported this notion as they took advantage of the genre templates as a method for planning the organisation of this diverse information.

There was no statistically significant difference between use of the discussion template, presentation $df=1,58$, $p=.215$ and quality of argument $df=1,58$, $p=.278$ when organising diverse information. However, the qualitative data suggested students believed the
structure of the discussion template was easy to use, could be manipulated while completing a task, in an appropriate time frame for that particular task. Students also kept the structure of the discussion template while constructing their answers and discarded the structure when they felt that they had the task under control. They also felt that the discussion template helped to remind them of how to organise their thoughts, knowledge and information. Students believed the interactions with the discussion template helped them to learn more about the problem being investigated. As a result, student responses that further identified and supported students' use of the discussion template in the areas of presentation and quality argument.

2. How does the genre template help the student organise information?

The genre template helped students to organise information in a variety of ways because it was easy to find, self explanatory and gave student reports a direction. Students used the genre template at the beginning of their task and disregarded the structure at the end. The control group who did not use the genre template just gathered information on the side mainly in the PDA. For the students who used the genre templates, the analysed data revealed that the majority of them kept the structure of the discussion template while constructing their answers and discarded the structure when they felt they had the task under control. Students also felt that the discussion template helped to remind them of how to organise their thoughts and gather information. They believed the interactions with the discussion template also helped them to learn more about the problem being investigated while at the same time not feeling constrained by the template structure.
3. How do students use the cognitive support templates? What approach do students use?

Students used the templates by accessing them and keeping the structure of the genre template as they completed their task investigation. Students copied the task investigation into the genre template or PDA, then used the PDA to collect information and copied the discussion template to the Text Tablet before entering their notes and information. The students continued to copy their notes and information from the PDA to the appropriate sections in the discussion template within the Text Tablet. Finally they reviewed their notes and information sources to synthesise a response to the task, removing the structures of the genre template within the Text tablet only.

Students in the experimental group approached their investigation problem by looking at the overall problem first; this included accessing the genre template at the beginning of the task. This approach allowed them to learn more about the problem and break it down into smaller parts. The control group looked at the overall problem and did not think to break the problem down into appropriate parts as suggested by the genre templates.

4. Is there a relationship between student approaches to learning and the use of cognitive tools in problem-based learning?

Summary of quantitative data from the statistical analysis of the LPQ on approaches to learning suggested that there was an overall effect. For the independent measures of learning outcomes and presentation, the Deep and Achieving and Surface and Low Achieving approaches showed interaction effects with the use of the genre template when synthesising a written response to a problem.
However, the overall size of the group was too small to make a stabilised comparison and draw significant conclusions. Further research with larger group numbers may result in the learning approaches being supported by the templates.

5. Can students identify other tools for support in organising information that is presented in multiple modalities for representation?

Students identified concept mapping as another way to organise information and formulate knowledge that is presented in multiple modalities for representation. These tools may support learners in the area of presentation and quality of argument for template use and approaches to learning and cognition.

Other useful tools mentioned included editing facilities for teachers and students to gain access to information more readily. Students believed that tools that also need to be included were ones that gave immediate response and feedback to user investigation input in the form of simulation, games and rewards.
Chapter Five - Findings and Conclusions

This is a report on an investigation into how learners used genre templates for the writing process while completing a problem-solving task. The genre templates, when used in conjunction with other embedded resources, helped learners to produce more organised and structured reports. *Exploring the Nardoo* supported a constructivist approach to learning with problem solving as the student task. This study was based upon the contention that technology-based genre templates provided support for student learning outcomes especially for learners who employed poor metacognitive strategies.

STUDENTS' USE OF THE GENRE TEMPLATES

The genre templates provided support for students while in a complex information landscape. For example, learners who used the templates were more able to synthesise information into meaningful knowledge and concepts. Students who used the genre templates scored higher on the learning outcome measures than those who did not. Data from the student task results (learning outcomes), post treatment questionnaire, interviews and observations all supported students' use of the genre template, in that there was a positive difference in learning outcomes, style and choice of information, between those who used the discussion template and those who did not. There was no significant difference between those who used the genre template and those who did not on presentation and quality of argument. Providing students with access, knowledge and use of the genre templates, gave them a
more appropriate style and structure to use in their decisions about the presentation of information they gathered while problem-solving.

Learner use of the genre templates provided students with a framework for the planning and organisation of thoughts by assisting students in the scaffolding and modelling of information. The genre templates assisted the students writing processes and functioned as cognitive tools in that they reduced the need to structure information being collected. Students' felt that the templates provided them with ways to assist in organising ideas. Learners who used the genre templates were more able to synthesise information into personally meaningful knowledge and concepts.

STUDENTS' UNDERSTANDING OF THE GENRE TEMPLATE AS A COGNITIVE TOOL

Problem-solving tasks that require the manipulation of multimedia are not only making learning more interesting: they are also encouraging speed and accuracy of recall and interaction. The refinement of specific skills for problem-solving tasks may be improved through practice and motivation. For example, motivation in the form of rewards, as suggested by students in this study, may be made more interesting, engaging and interactive if presented as games, personal challenges or humorous activities, when there is immediate feedback and reward. Students also requested that the results of their work be evaluated from multiple perspectives as part of their thinking processes. The software package used in this study provided to students varied and stimulating ways of practicing skills and developing concepts.
Results from the study found that learners who benefited from the use of the genre template in their learning outcomes and presentation were the Deep and Achieving and Surface and Low Achieving learners. Biggs and Moore (1993), claim that complex learning and problem solving can be improved markedly by helping students become more metacognitive in their approach. This means giving students the skills to be able to complete complex cognitive activities while carrying out a task. These skills included: planning and deciding what their goals are; what strategies to use to get there; deciding what further knowledge or resources they need; monitoring progress on the way, (are they going in the right direction?); evaluating when they have arrived; and terminating when the goals have been met.

Of importance in using the software package *Exploring the Nardoo* for this study was the inclusion of the Report, Explanation, Procedure, Exposition, Discussion, Narrative, Recount, and Review genre templates that manifest as a melding of most methods of communication—written, oral, visual and aural. This study also found that the genre templates provided a means of composing meaning for both the writer and the reader/listener while at the same time providing a means of reflection, re-ordering and creating new learning modes and links between new and prior knowledge (Harper et al., 1996).

Students that have been set an appropriate task, one that may be clearly understood and challenging, yet possible to complete with some success depending on the strategies they choose to use, can benefit from the use of genre templates. Having the availability of a range of genre templates, with added character-guide or text-based support, provided evidence for strategies that helped students
encode the information they encountered (Schroeder & Kenny 1994, p. 963). Through the use of the genre templates students can be further encouraged and motivated to explore and discover the potential of technologies when it is appropriate for them, rather than just be shown how to follow convention or rules. The production of an effective piece of writing or presentation in any media, with the help of the genre templates as a scaffold, provided the student with a means of consolidating their own links or ideas. The genre templates have helped students identify and use a framework for recording and ordering ideas that can be built into a structured piece of writing.

Improving a student's metacognitive processes can also enhance the student's confidence, self esteem and motivation to stay on and complete a task. The New South Wales department of Education and Training Curriculum Support Directorate already suggest this, in that the student's confidence, self-esteem and motivation may be linked to the attributes of a specific software to make choices about the type and direction of the learning activities in which the students engaged (Metropolitan West, 1997, p. 6). Initially, access to and knowledge about the genre templates provided the stimulus and motivation to undertake tasks that students may otherwise avoid. For example, when students were set a task that could make use of the genre templates, students chose and preferred to use the genre template because: they already had experience from a variety of subjects in the use of genre models for organising their information; they were not comfortable in organising information; or they needed a starting point. Some students believed the genre template gave their article direction and found it easy to use while others felt that they could expand on necessary points when they needed to and that the template structure provided a scaffold
whereby students could organise their thoughts. On the other hand students may have followed the genre template structure instead of developing their own genre structure. This may have been caused by lack of motivation or thought that this was required as part of the task outcome; and supplying evidence of genre template use, this would have then given them higher marks. However, interviews with individual students revealed that students believed the interaction with the genre templates helped them to learn more about the problem and gave them confidence and motivation to stay on task for a variety of reasons already mentioned.

Facilitating metacognitive skills and strategies

Educators need to facilitate the development of skills and strategies for higher order-thinking processes and metacognition as beginning points. Thus learners with poor metacognitive skills will not be disadvantaged when organising knowledge during the learning process. Students who have more appropriate metacognitive skills are said to be metacognitively aware and can reflect, critically and realistically, on what they are doing, it helps them cope with new and complex situations of all kinds (Biggs & Moore, 1993, p. 332). This study provided an indication that learners who possess the characteristics that are consistent with deep and achieving approaches to learning and used the genre templates produced a more structured response to a problem than learners who possessed these characteristics and did not use the genre templates.

With a deep approach, the student will:

- possess a great deal of relevant content knowledge;
- operate at a high or abstract level of conceptualisation;
• reflect metacognitively on what is to be done, using optimal strategies for handling the task;

• enjoy the process; and

• be prepared to invest time and effort.

Like the deep approach, then the achieving approach involves a high degree of metalearning, relating both to context (awareness of self, task and context, with deliberate planning of time and resource allocation) and to content (optimal task engagement). (Biggs, 1997a).

The result of this study showed that the genre templates helped students who already possessed metacognitive skills and strategies. These were the deep achievers, who operate most effectively when they are consciously aware of their own learning processes. These students were aware of the use of genre templates and used them to their full potential.

Further findings showed that the surface and low achieving students in the treatment group when compared to the deep achievers in the non treatment group improved in the areas of learning outcomes and presentation. This may have been due to surface and low achieving students using multimedia resources as a scaffolding process rather than a particular style of genre for presenting and organising information.

Scaffolds may be used by expert students as part of the planning process and as part of the development of higher order thinking skills in situated learning environments (Hannafin, 1997, p. 12). In all cases, when approaching a task the student operates abstractly, using a conceptual framework that subsumes the relevant detail (Biggs & Moore, 1993, p. 312).
The conclusions of this study supported Biggs and Moore’s contention that the surface approach is used with less evidence of metacognition (p. 311). However it also recommends that the surface achieving students need instructional treatment with organisational skills and time management (Table 3.4). This study also found that the genre templates provided support to these students to further develop their cognitive structures.

Scaffolds are not needed when cognitive structures are sufficiently developed; they are needed while the structures are incomplete or unstable (Brown & Palinscar, 1989). Scaffolding supports and simplifies a task as much as is necessary to enable learners to manage their learning, allowing them to accomplish otherwise impossible tasks and helping stabilise cognitive structures for both deep and achieving and surface and low achieving learners when considering their metacognitive strategies and skills.

If students are employing metacognitive strategies and the genre templates have helped them, then it is possibly due to several factors. Such factors could include whether or not working memory space is available and whether or not the learner has the procedural knowledge for handling the task in question. As a personal digital assistant was available within the CD-ROM and used by the learners as working memory space, we may presume that there was enough memory space available.

People with little time or who are overwhelmed by the complexity of the task or by the situation will not process at a meta level they will just charge ahead. Deep and achieving approaches need more time and space within working memory for reflective activity than surface when the task is complex. Factors which crowd working memory will thus increase the likelihood of a surface approach (Biggs & Moore, 1993, p. 321).
It could be argued from the data that the templates do not crowd working memory, but that they enhance it by providing a space for reflective and organisational activity during the general learning process.

This study identified the general learning processes that students demonstrated while using the genre templates as a cognitive resource. These were to copy the investigation and use the PDA to collect information; copy the discussion template to the Text Tablet before entering their notes and information. The students then copied their notes and information from the PDA to the appropriate sections in the genre template within the Text Tablet and then reviewed their notes to synthesise a response to the task.

Learners need to acquire strategies for self-direction and autonomy in learning. To do this, they need to be taught strategies within the context in which they are to be applied, this gives more satisfactory results (Biggs & Moore, 1993). This study supported this conclusion. However, this process requires tailoring strategy-training programs into the normal teaching process. One way of doing this is by having students identify how they formulate the processing of knowledge with the use of visual construction tools; for example, concept mapping, as suggested in this study by students themselves. Sixteen students said that they normally approached a problem to solve by using a concept map. Twelve students said they used a linear approach and over half of the students used the genre template at the beginning of the task. Alternatively, visual construction tools may be embedded, for example, concept mapping (cognitive tools) as starting points for surface and low achieving learners into well designed interactive multimedia programs that support student centred learning. Only then will learners be given the opportunity
to acquire strategies for self direction to become aware of the processes of learning, as distinct from the content of learning, to improve their learning outcome and develop higher order thinking skills.

By providing genre templates as cognitive tools that facilitate metacognitive skills and strategies, educators are increasing opportunities for student interaction and decision making. Tasks that provide students with a way of planning and monitoring interactive learning can often engage students in interactions that range from responding to simple prompts to complex decision making and planning. Students can select tasks, work at levels that meet their particular need or take responsibility for the management of entire activities. The value of interactive resources lies in the opportunities provided to students, to direct their learning and to pursue information, or complete tasks, in ways that meet their own interests and needs.

Teachers can tailor learning experiences and facilitate strategies, to meet the specific needs of students in interactive learning environments, by offering choices as to the type of activity, level of difficulty and speed of interaction involved. More importantly, learners need to know that learning environments contain cognitive tools so that they can develop new metacognitive skills and strategies to use the technologies effectively.

*Development of dynamic tools*

The development of dynamic cognitive tools to further support learners with a surface and low achieving approach is needed to help them process information more effectively. More importantly, these tools need to be developed and designed so that they are
tailored with instructional strategies, for example, visual-thinking tools such as a concept mapping tool. This is so learners themselves can account for the procedural and conditional knowledge of learning. Such knowledge is particularly important in carrying out complex cognitive activities (Biggs & Moore, 1993, p. 308). This study suggested that educators need to design, develop and integrate more dynamic cognitive tools into the learning process, at the beginning of the knowledge construction process, particularly for surface and low achieving learners. Participants in this research have suggested what form these new tools or thinking structures should take, for example concept mapping, visual thinking tools, simulations, planning, thinking and reflection tools.

When learning occurs with more sophisticated visual thinking tools, structures, multiple media and in open-ended constructivist learning environments; ways of assessing students use of and interaction with these tools need to be adhered to by designers, teachers and researchers. Findings from this study included developing and providing an assessment protocol to be used in this type of learning environment. Collins (1990), claims that traditional testing strategies need to be revised as they are counter-productive for the solving of real world problems. The assessment protocol criterion that was developed by students, teachers and the researcher of this study and successfully implemented was a strategy and tool which still needs to be further developed and researched.

**Recommendations for further research and future directions**

This study did not investigate how changes in metacognition, nor transfer of skills in users have developed with this application. The
following suggestions for further study have been derived from the initial outcomes of this study. Suggestions include:

- A study using two or three different learning environments, for example, a selective high school, a non-selective high school and an independent high school.

A replication of this study with a variety of different learning environments might demonstrate a broader scope for the use of genre templates or scaffolds by different types of learners. This may give a clearer indication of what types of learners and learning environments could take advantage of using the genre templates, or whether or not there is a difference when using the genre templates in a particular school.

- Further research into the effect a variety of complex thinking tools may have on the learning process over a longer period.

The further investigation of refined cognitive tools from student suggestions may provide a wider use of learner engagement tools. The provision and use of these tools may motivate and encourage learners to stay on task longer, reduce cognitive load associated with task completion and support the development of an argument when synthesising a response to a problem.

- It may prove useful to examine social-interactive and teaching style variables in addition to the ones that were measured in this study.

This may give a more complete view of the changes that have taken place in the whole learning environment due to the introduction of the genre templates which were embedded in an information landscape as cognitive resources.
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Appendix A

INSTRUCTIONS ON THE USE OF
NARDOO GIVEN TO ALL STUDENTS

Instruction was given to the participants in both the control and experimental group. Students in the control group did not have instruction on templates or use of the presentation guides.

Instruction on how to use the software package *Exploring the Nardoo* was given by students completing an orientation session overview on the package *Exploring the Nardoo*.

*Exploring the Nardoo an overview*

The researcher gave students step by step instruction on how to navigate and select an investigation. Instruction on how to load a genre template and save their student notes to a disk were also demonstrated by the researcher.

Time was allocated for questions.

Students completed the Help videos within the CD-ROM *Exploring the Nardoo*, consisting of videos

- Personal Digital Assistance

- Water Research Centre

- Investigations and

- Glossary Video /optional

All students completed the Orientation session, a set task, saved their notes to a disk, completed the GEFT, LPQ and post treatment questionnaire.
The following supporting documentation is located on the CD-ROM and is available to teachers and researchers;

Treatment Overview

Curriculum Statement

Teaching and Learning Strategies

Student Task (investigation)

Teacher notes

Discussion template and Scaffolds

*Exploring the Nardoo* is the most recent investigative multimedia package to be developed by the Interactive Multimedia Learning Laboratory within the Faculty of Education at the University of Wollongong.

It has been cooperatively developed with the New South Wales Department of Land and Water Conservation with the intention of heightening public awareness of water resource management issues, particularly those related to inland river systems.

The IMMLL group have built upon the experience gained from their previous software title - *Investigating Lake Iluka*, and produced an interactive experience which supports the existing senior Biology, General Science and Geography related curriculum areas. The rich information base within the package, as outlined below, will also allow teachers to adapt it for use in other curriculum areas.

Scientific investigation, reflection and analysis in the process of generating or refining knowledge are skills students will employ when exploring each of the twelve investigations embedded within a geographic metaphor of an inland river catchment area. The catchment has been divided into four regions along the length of the river and can also be investigated through three stages of development or 'time zones'. The time zone that is of interest for this study and task to be employed is described below.
The following supporting documentation is located on the CD-ROM and is available to teachers and researchers:

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Exploring the Nardoo curriculum statement

Although Exploring the Nardoo has been designed to support and complement the study of ecology and physical geography in the senior school, the richness and nature of the information landscape would allow students in various disciplines and at various levels (years 7 through 10) to gain valuable knowledge, insight and experience in ecological issues. Additionally, the nature of the package allows users to gain experience and practice in the development of skills such as problem solving, measuring, collating, and communicating without the need to be concerned with the complexities of the subject matter. With teacher guidance, students at all levels of ability could gain valuable experiences based in a 'real ecosystem'.

Meeting Curriculum Objectives / Outcomes for Biology and Geography

Exploring the Nardoo has the potential to provide extensive opportunities for students studying Biology and Geography to extend and consolidate their knowledge base in many of the critical areas of their respective syllabi. In addition they can practice investigative, analytical and communicative skills as well as develop and appreciate different values and attitudes.

In both these subjects, it is often impossible to provide students with worthwhile experiences based on field work. Exploring the Nardoo provides a rich environment in which many of the aspects of a river ecosystem are accurately simulated for the student in a comfortable and supportive classroom environment.
Independent Investigation used for the research study

Time Zone 3: 1960's-70's

Merringurra Region

Dam Construction

Pilliga Dam has been constructed in the Merringurra Region of the Nardoo River. At the time of development, environmental groups were concerned about the effect that the dam may have on the Nardoo River valley.

Your task:

Investigate the issues surrounding the construction and impact of Pilliga Dam and write an article for the local newspaper that discusses the effect the dam has had on the area.

1. Select the investigation from the Investigations Board in the WRC and listen to what the guide has to say. Follow the instructions and use the Grab button to enter the problem in your note book.

Note: You may now, if you wish, click on the guide several times to hear all the levels of help that can be given to you.

2. Your task: Investigate the issues surrounding the construction of a dam in this area. What are the advantages of having a dam in the area and how will it impact on the physical structure of the river. Will it have a noticeable change on the living things in the area? How will people downstream cope with reduced or restricted water flow? Will it be an advantage in times of flood? Will it greatly effect the wetland areas of the catchment?

Write an article for the local newspaper that discusses the effects of the dam in this area.

Note: See the Presentation Guide for information on how to use the discussion style of presentation.
3. Use the Go button on the PDA to go into the area under investigation in the environment and use the tools to take and record physical and chemical measurements above and below the dam. Then move back in time and take similar measurements in Time Zone (1) for this region at the same places.

How do they compare?

*Note: Some students may need early support. They may find that going to the filing cabinet first and reading about dams and their impacts will give them ideas to start exploring effectively.

4. Explore the river environment and use your mouse to click on hot spots that appear. Ask your teacher for help if you cannot find any.

5. Alternatively, stay in the WRC and explore the resources within the research centre.

6. Click on the Video Clipboard. Go to the sheet containing material on the Merringurra. View the following videos by clicking on them.

* Company reveals Development plan.

Where is the proposed urban development going to be built?

Why are they considering building it there?

What will be the function of the dam?

* Company reveals Development strategy.

What effects do people consider the dam is having on the catchment?

Why is a water management plan needed?

What are some ways of controlling the water?

7. Click on the Radio Clipboard and turn to the page for Merringurra. Listen to the following radio clips by clicking on them.

* Council proposes new Town.
What is the opinion of the well know local Jessica Hansen on this matter?

What does she think will happen? Should it go ahead?

* Cotton farmer defends Dam.

What has been the effect of low rainfall in the area?

Why is the farmer upset about water use?

What does he think about the role of cotton farming in the area?

What does he think about the greenies' worries about the Red Gum forest?

* Dam Encourages Tourism.

What has the dam done for tourism in the area?

Do you think the dam is a good thing for the area?

Give your reasons.

8. Click on the Filing Cabinet. Open the folder marked River Regulation

Read and collect to your notes information which you think is important from any or all of the documents within, especially those called:

Effects of Development on Water Quality.

Changes in the environment from River Regulation.

Allocation of Surface Waters.

Water as a constraint on Development.

9. Click on the Newspaper Clippings folder for information on:

- effects of sedimentation in the dam on water storage capacity;
-effects of reduced flow on down stream vegetation.

10. Click on the simulator if you would like to try your hand at managing water allocation from a dam in a real catchment area. The guide will help you or you can ask your teacher if you are not sure what to do. If you want detailed information on the simulation, open the folder on simulations in the filing cabinet.

11. Copy your notes and any media you have collected from your PDA into the text tablet. Use the editing tool and the presentation guide to arrange and edit your work into an acceptable answer in the style suggested by either the WRC worker for this investigation or your teacher.

DISCUSSION TEMPLATE GIVEN TO ALL STUDENTS IN THE EXPERIMENTAL GROUP

Title:

INTRODUCTION Introduces the issue and gives some background information

ARGUMENTS FOR:

(1)

(2)

(3)

ARGUMENTS AGAINST:

(1)

(2)

(3)

CONCLUSION
More details on the use of this writing template and examples can be found in the Presentation Guide book located on the table beneath the Investigations Access to the information about the discussion genre given to all students in the Experimental group.

About the discussion Genre:

A DISCUSSION is an argument type text presenting information about BOTH SIDES of an ISSUE and then forming some opinion based on the arguments.

A good discussion contains:

- an introductory paragraph which introduces the issue and contains some background information;
- additional paragraphs presenting arguments FOR the issue and expanding on the ideas presented;
- additional paragraphs presenting arguments AGAINST the issue;
- a concluding paragraph briefly summarising the arguments and stating the writer's recommendation based on the weight of the evidence.

Useful things to remember:

- Ways to open the introductory paragraph.

There are both advantages and disadvantages in...... It is often argued that......

- Ways to introduce another viewpoint.
Although...... Despite this...... On the other hand...... More to the point is......

- Ways to sum up

It would seem that...... Consequently it seems better to...... On balance, it appears...... It would appear reasonable to......

How a discussion is organised(Example)

Title:

Damming the Nardoo: The case For and Against

INTRODUCTION: There are many people who live in the Nardoo river catchment area who believe ...

On the one hand ...

ARGUMENTS FOR

(1) The Pilliga dam will provide a reliable supply ...

(2) It will allow for future developments in ...

(3) During dry periods, the river can have many ...

Use a connecting phrase.

On the other hand, the opponents of the dam make ...

ARGUMENTS AGAINST

(1) The dam will cause river degradation ...

(2) Unless the dam is managed carefully ...

(3) The environment below the dam will suffer ...
CONCLUSION

On balance it would seem that although the damming of a river such as the Nardoo causes some problems.