

The role of metacognitive reading strategies instructions and various types of links in comprehending hypertexts

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The advent of computer and Internet technology enables hypertext, hypermedia and e-learning to be involved in the vocational education and training area. Hyperlinks play a significant role in hypertexts and e-learning systems, since they are connections among different nodes of information. Besides textual links, hypermedia systems provide access to various links that include multimedia applications, such as pictures, and audio clips. Therefore, comprehending information presented in hypertext/hypermedia systems and e-learning systems utilising appropriate reading strategies becomes crucial. This paper adds a new dimension to the existing body of research by investigating the influence of metacognitive strategies training and different types of hyperlinks on reading comprehension of hypertexts. A comparison of comprehension outcomes for hypertexts with text, picture and audio links is presented in order to illustrate the relationship among hypertext comprehension, types of links and learning styles. Also theoretical and practical implications of this research are presented.

Keywords: hypertext comprehension, metacognitive reading strategies, hyperlinks

Introduction

The development of computer and Internet technology has brought a number of new concepts to the education and training domains, including hypertext, hypermedia and e-learning (eg. Conklin, 1987; Rosenberg, 2001). Salmeron, Canas, Kintsch, and Fajardo (2005) define hypertexts as information systems with organised document contents in an interrelated network and established links that maintain the relationship among documents. Hyperlinks play an important role in both hypertext and e-learning contexts (Holmes & Gardner, 2006; Oliver & Herrington, 1995; Slatin, 1990) as they are considered to be a core element in these contexts (Holmes & Gardner, 2006; Oliver & Herrington, 1995). Recently the notion of hypertext has been expanded to a larger scale, and is referred to hypermedia (Conklin, 1987). Conklin (1987) suggests that hypermedia include every special feature that hypertexts have, such as non linearity and links, as well as “graphic, digitised speech, audio recordings, pictures, animation, film clips” (p. 18). Moreover, Oliver and Herrington (1995) and Landow (2006) point out that hypertext and hypermedia have been used interchangeably with the rapid development of technology.

As hypertexts and hypermedia have been increasingly involved in education (Chen, Fan, & Maredie, 2006; Oliver & Herrington, 1995; Salmeron et al., 2005), the term e-learning has been created in association with this new trend (Holmes & Gardner, 2006; Rosenberg, 2001). Holmes and Gardner (2006) define e-learning as “...online access to learning resources, anywhere and any time” (p. 14). This definition stresses the importance of accessibility to information in the e-learning context.

E-learning offers an effective and convenient approach in teaching and learning. It helps students and teachers build up various learning communities online in specific domains they are interested in, which, in turn, allows to communicate in relation to their learning experience at the time and location convenient to them. Furthermore, e-learning decreases training and learning costs, that include travel expenses, time for staff training, as well as classroom and instructor infrastructure construction expenses (Rosenberg, 2001).

Interacting with e-learning materials such as hypertexts, is one of the interesting areas of e-learning. In particular, successful reading and understanding of hypertexts which requires that students constantly monitor the reading process. While reading, they should be able to identify when comprehension fails, and apply appropriate strategies to repair it. Thus, the aim of the current research was to investigate students' reading and learning behaviour in the e-learning environment. In particular, the study investigated the influence of metacognitive strategies training and types of hyperlinks on comprehending hypertexts. It was predicted that although training would result in improved overall comprehension, differences in comprehending hypertexts with text, picture and audio links would occur.

Different types of hyperlinks

Hyperlinks are considered one of the key elements of hypertext/hypermedia, because they connect different chunks of information in hypertext/hypermedia systems and carry users from one chunk to another (Mazzali-Lurati, 2007; Morgan, 2002; Slatin, 1990). Furthermore, they play the same role in the e-learning environment (Holmes & Gardner, 2006). A hyperlink represents the electronic connection between two pieces of information in a hypertext system, which leads to different information retrieval orders and sequences (Mazzali-Lurati, 2007; Slatin, 1990). Once two pieces of information have been connected by a hyperlink, they become hypertext nodes (Slatin, 1990). According to Slatin (1990), a node could be a piece of text, a picture, a diagram, a set of data, an audio clip, or a movie clip. Also, it could be a combination of the above items in hypermedia context. Thus, hyperlinks offer routes to various nodes; while nodes present contents which can be reached by clicking on different hyperlinks.

Normally hyperlinks are either bolded or underlined, especially if they are embedded textual links, in order to remind users that there are links that lead to other important information (Bernard, Hull, & Chaparro, 2005; Mazzali-Lurati, 2007). Besides, it is also suggested that hyperlink wording plays a vital role in hypertext browsing and navigation, because every hyperlink informs users what they will read in a new node, as well as attracts their attention (Wei et al., 2005).

Embedded textual links contribute two major advantages to hypertext learning and reading (Landow, 2006). Firstly, readers are able to preview and predict the up-coming information as long as links are labelled clearly. Secondly, embedded textual links could create different link behaviour, including pop-up windows (Landow, 2006).

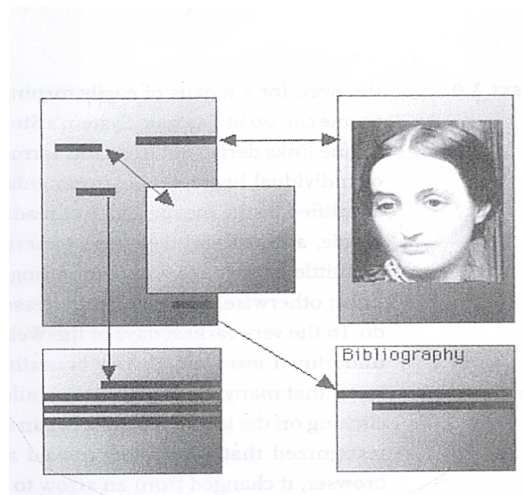


Figure 1: Different types of links (Source: Landow, 2006, p. 19)

Landow (2006) implicitly illustrates contents to which typed links lead by using a diagram _Figure 1_. In his diagram, it is shown that embedded textual links are empowered to connect texts, pictures, short explanations, and audio/video clips contained in new links. In this case, learners are able to obtain information in different media formats. For instance, texts in new links could be used to introduce background information of a particular topic; explanations could be employed if there is any new terminology in relation to the introduced topic; pictures could be utilised to assist and strengthen learners' visualisation; while audio/video clips could be helpful for learners to acquire new information from a multimedia perspective.

In general, hyperlinks play a significant role in the web-based learning environment, because they are learners' accesses to the information they demand (Oliver & Herrington, 1995; Slatin, 1990). In this case, how learners search and reach the desired information should be fully understood.

Metacognition and metacognitive strategies

Metacognition was first introduced in the 1970's by Flavell and has widely attracted attention in the domain of education (Baker, 2005; Samuels, Ediger, Willcutt, & Palumbo, 2005). Flavell (1979) describes meta-cognition as "knowledge and cognition about cognitive phenomena" (p. 906). In addition, he also suggests the importance of metacognition in both education and psychology fields. The definition of this particular notion has been developed and expanded as in-depth research has been conducted. Baker and Brown (1984) decode metacognition into two categories: knowledge about cognition and regulation of cognition. Knowledge about cognition focuses on one's own awareness and appraisal of one's cognitive process; while regulation of cognition takes into account self-regulation and strategies leading to the achievement of self-regulation (Baker & Brown, 1984).

Samuels et al. (2005) acknowledge that there are three factors related to personal cognitive processes that constitute the notion of metacognition; the nature of the task that learners are expected to carry out; various approaches to achieve it under different circumstances; and strategies that enable learners to monitor and regulate their cognitive processes. In comparison to Backer and Brown's (1984) interpretation, Samuels et al. (2005) put emphasis on the nature of the task, which also implies that learners should choose metacognitive strategies accordingly in order to achieve the task. In fact, Baker and Brown (1984) made a similar statement regarding the relationship between the task and strategies: "Strategies vary, depending on the goal of the activity." (p. 354) Therefore, metacognitive strategies play crucial roles in learning and its achievement. Furthermore, with the development of hypertext/hypermedia and e-learning, the importance of metacognitive strategies becomes increasingly obvious (Lee & Baylor, 2006; Verezub, Grossi, Howard, & Watkins, 2008).

Although being worded in different ways, metacognitive strategies proposed by different researchers and theorists still enjoy similarities (eg. Brown 1980, cited in Baker & Brown, 1984; Palinscar and Brown 1989, cited in Verezub et al., 2008). Lee and Baylor (2006) use four key strategies that are proposed by Brown (1987, cited in Lee & Baylor, 2006) to illustrate the importance of metacognition in the web-based learning environment. These four strategies include planning, monitoring, evaluating, and revising. Planning describes an overview of how the learning will be carried out; monitoring is related to controlling the undergoing learning process; evaluating refers to the assessment activities of current learning; revising involves activities to correct previous mistakes and adjust previous learning plans and other strategies. Finally, Lee and Baylor (2006) suggest use of a metacognitive map to assist learners in the e-learning environment, because it not only helps learners with their metacognition in learning, but also contributes to the reduction of disorientation.

Learning styles and their implications in web-based learning

Individuals have different preferences about the way they learn, and strategies they utilise in both traditional and e-learning contexts (Akdemir & Koszalka, 2008; Dunser & Jirasko, 2005; Federico, 2000). The above preferences are referred to learning styles (Dunser & Jirasko, 2005). A number of influential theories and models related to learning styles, such as Felder's models of learning styles (Felder, 1993), have been developed.

Felder (1993) demonstrates five different categories of learning styles, including sensory vs. intuitive, visual vs. verbal, inductive vs. deductive, active vs. reflective, and sequential vs global. Firstly, sensory learners prefer to receive information through their senses, such as sounds, sights, and physical sensations; while intuitive learners prefer to obtain information internally from their memories, reflection, and imagination. Secondly, visual learners tend to receive more information from pictures, diagram or graphics that surround them; while verbal learners tend to learn more from written and spoken words and mathematical formulae. Thirdly, inductive learners are those who observe facts first and then infer general principles and theories; while deductive learners are those who learn general principles first and then generate consequences and applications. Fourthly, active learners obtain information from practising various activities and working out new ideas; while reflective learners think carefully before practising

new activities or ideas. Lastly, sequential learners process new information step by step; while global learners take fragments of new information and form a big picture of the whole.

Dunser and Jirasko (2005) employ the model of sequential vs. global learning styles to examine the relationship between learning styles and hypertext learning. The results reveal that sequential learners will benefit by hypertext systems with structural aids attached. On the other hand, global learners are not influenced by the additional structural aids. Given the non-linear and non-sequential nature of hypertext, it is also suggested that additional linear aids in hypertext systems do not degrade global learners' learning achievement, but increase sequential learners' learning outcomes.

Methodology

Participants

The participants of the study were 31 first year students studying the Diploma of Conservation and Land Management course at Swinburne University of Technology, Melbourne, Australia. The rationale for selecting this cohort was as follows; with on-line delivery becoming mandatory, students are required to read and comprehend many e-texts. Incorporating training to read hypertexts into subject-specific context was expected to improve the learning outcome. To conduct the experiment, Ethics Approval was obtained from Swinburne University. Also all students signed the consent form and agreed to participate in the project. The ratio of male to female students was 14:17, and the ratio of students who were English native speakers to students of non-English speaking background was 27:4. All participants were from an average socio-economic background; they did not have any learning disabilities and attended the classes regularly.

Instructional material

Due to their content and structure, expository texts were used to investigate students' use of metacognitive strategies in the hypertext context. The texts were selected in consultation with the subject teacher, from a variety of sources and were relevant to different aspects of Land and Conservation management. The structure of the developed website was as follows; the Home page gave an introduction to the 'Plan River Restoration Works E-learning Program'. The main menu provided links to five sessions; each session consisted of three hypertexts (Table 1). The first and the fifth sessions were pre- and post- test sessions, with three 500 word hypertexts. The first text (in both sessions) consisted of text links only. The second text had picture links only and the third one, audio links. In relation to the second, third and fourth sessions which were training sessions, all three hypertexts in the second session consisted of text links only; texts in the third session had picture links, and the texts from the fourth session were audio.

Table 1. The structure of sessions

Session No	Hypertext Title	Type of links	Text length (in words)
Session 1	The Riparian Zone	Text	500
	Wetland and Waterways Types	Picture	500
	Wetland and Waterways Values	Audio	500
Session 2	Riparian Vegetation	Text	300
	River and Stream Sediments	Text	400
	Water Regimes	Text	500
Session 3	Large Woody Debris: Past Management Practices	Picture	300
	Ecological and Habitat Values	Picture	400
	Current Management	Picture	500
Session 4	Riparian Zones: Livestock Impact	Audio	300
	Managing Livestock	Audio	400
	Fencing	Audio	500
Session 5	Salt in Wetlands and Waterways	Text	500
	Algae in Wetlands and Waterways	Picture	500
	Water Temperature	Audio	500

The rationale for selecting three types of links was as follows; it was predicted that the quality of teaching would be enhanced if different learning styles (e.g. visual) were addressed. Although the students' learning styles were not identified by formal testing, conversations with the subject teacher proved that various learning styles were present in this cohort. Thus, it was decided to address a variety of learning styles by designing hypertexts with text, picture or audio links, and to teach students to apply reading strategies appropriate for each situation.

The structure of hypertext was presented by linear links. The choice of linear linking for hypertext was made for the following reasons. Simplicity in navigation is essential for learners (Ambron & Hooper, 1988). The less users have to think about navigation related issues, the more they can concentrate on the subject matter being presented, and hence the greater their learning (Apple Computer Inc., 1990). Also, many hypertexts, especially those developed for reading and comprehending in the classroom, are of a linear form (Oliver & Herrington, 1995; Verezub, 2004).

Instructional phases

The study was conducted in three phases and involved the following student activities:

1. At the pre-instructional phase (session 1) students were asked to read three hypertexts (one with text links; the second one with picture links; and the third one with audio). Students' reading comprehension was assessed using two comprehension tasks – answering the questions and filling in the gaps (a cloze task).
2. At the instructional phases, using a teaching regime extended over three sessions, students were taught how to monitor their comprehension.
3. At the post-instructional phase (session 5) students' reading comprehension of hypertexts was assessed using two comprehension tasks similar to those in the first session.

One and a half hour training sessions were conducted with the group of Diploma students on a weekly basis in semester 1, 2007. Training was based on principles of explicit instructions (Duffy, 2002). The aim of training was to teach students to be metacognitive in their reading, i.e. "...the ability to identify which strategies are effective for specific contexts and the ability to select the optimal strategy to improve comprehension" (McNamara, Ozuru, Best, & O'Reilly, 2007, p. 469). Also, students should be able to monitor the effective use of these strategies, and the whole reading process. The skills which were explained and modeled during three training sessions were predicting, summarising, paraphrasing, visualising and questioning.

The delivery of training sessions was as follows. At the beginning of each session before reading a hypertext, the trainer asked students to make predictions about the text structure and content based on the title. Also direct explanation was provided in relation to steps necessary to achieve effective comprehension using the skills of paraphrasing, summarising, predicting, visualising and questioning. Next the trainer used a talk through procedure, in which the skill is applied to text, and reviewed the skills. Students were encouraged to contribute to the explanation. As students started reading the hypertext, the trainer asked them to check if their predictions about the content were right. In addition, students had to monitor their text understanding at various levels (e.g. word level, meaning level), identify when comprehension failed and apply strategies appropriate for each case. This part of training was conducted in small groups so students could discuss what had worked for them in different situations or express any concerns. The trainer gave feedback to groups and individual students before encouraging them to work independently. At the end of each hypertext reading, students were asked to complete a set of tasks, which included answering comprehension questions and a cloze task.

The system of assessment of comprehension tasks at each session was as follows. For answering the questions tasks, one point was given for a correct and complete answer; half a point was given for a partially completed answer; zero points for an incomplete or incorrect answer. For cloze tasks, one point was given for a full and correct answer; half a point for a partially completed answer, and zero points for an incomplete or incorrect answer.

Results and discussion

The influence of strategy training on the two types of comprehension: expressive comprehension (assessed using literal, inferential and critical expressive questions) and recognition comprehension

(assessed using a cloze task) was analysed using paired t-test. The results indicated that both expressive and recognition comprehension under the metacognitive training conditions was enhanced for hypertexts with text, picture and audio links (Verezub et al., 2008). Trends in expressive and recognition comprehension for hypertexts with text, picture and audio links are shown in Figures 2 and 3 respectively.

The results show (Table 2) that for both expressive and recognition comprehension, hypertext with text links dominated over hypertexts with picture and audio links. This is consistent with findings by Felder (1993) and Dunser and Jirasko (2005) that hypertext with text links represents "...a logical progression of small incremental steps" (Felder, 1993, p. 286), or sequential learning style. It is predicted that this learning style dominated in this cohort. Thus, by employing strategies appropriate for a particular situation, students monitored their comprehension when moving from one link to another.

In relation to hypertexts with picture and audio links, in expressive comprehension, students' understanding of hypertext with picture links was significantly better than of hypertext with audio links. Visualising from pictures allowed students to get more information than from spoken words (audio links). Students had to translate spoken words into mental images in order to understand them. It can be assumed that during the process of translating words into images, students tended to lose minor details presented in the sound links; however these details were required when answering the comprehension questions. Thus students were unable to present information in full details. This is in line with Felder's findings (1993) that sensory learners tend to obtain lower comprehension scores.

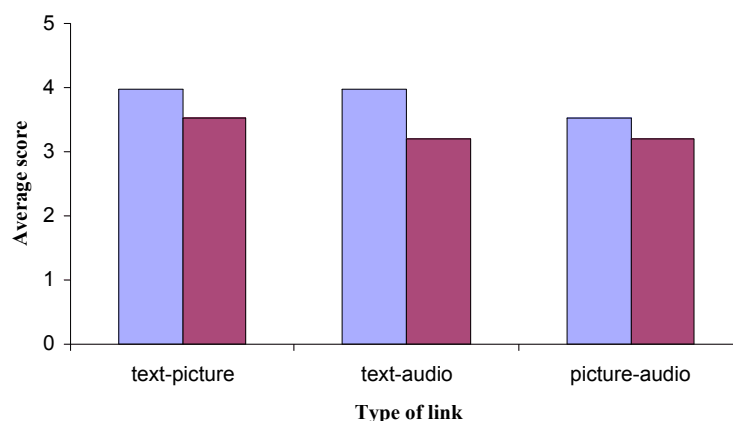


Figure 2. Trends in expressive comprehension after training sessions for hypertexts with different types of links

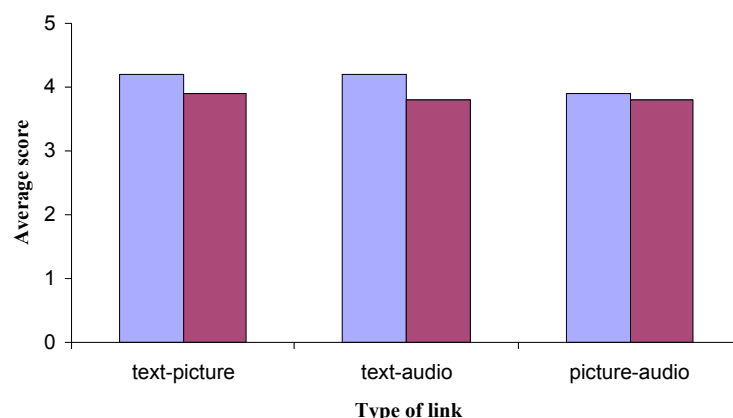


Figure 3. Trends in recognition comprehension after training sessions for hypertexts with different types of links

Table 2. The influence of text, picture and audio hyperlinks on expressive and recognition comprehension after training sessions

	T
Session 5; text-1; task-1 - Session 5; text-2; task-1	2.493*
Session 5; text-1; task-1 - Session 5; text-3; task-1	4.246**
Session 5; text-2; task-1 - Session 5; text-3; task-1	2.079*
Session 5; text-1; task-2 - Session 5; text-2; task-2	2.061*
Session 5; text-1; task-2 - Session 5; text-3; task-2	2.693*
Session 5; text-2; task-2 - Session 5; text-3; task-2	0.692

** p<0.01 level (2-tailed)

* p<0.05 level (2-tailed)

The results for recognition comprehension did not demonstrate any significant difference between reading hypertext with picture links and hypertext with audio links. This can be explained by the fact that the cloze task, measuring recognition comprehension, involved recognition of key words (i.e. major details). In the case of hypertexts with picture and audio links, students showed the same level of ability to monitor their comprehension and identify as well as to remember the critical content of the text.

Conclusion and implications for practice

Comprehending hypertexts can be a challenging task. Successful reading comprehension and learning not only require the application of the ability to select optimal strategies, but to monitor the application of these strategies as well as the whole process of reading. Web-based documents, such as hypertexts, allow the presentation of information not only in a text format, but also including pictures, audio, graphics, etc. This has many pedagogical advantages. The present study demonstrated the benefits of incorporating different types of links as it could address and accommodate learning styles of all students in the class. It was found that for our cohort of students, hypertexts with text and picture hyperlinks were particularly advantageous. Thus, addressing different sides of learning styles during teaching can strengthen students' less developed abilities, and ultimately, improve, the whole reading process.

The practical side of this research project was the development of an E-learning program (available on a CD) for the Department of Horticulture and Environmental Science. In the current era of fast technological changes, education and training do not have to be confined to classrooms. As a consequence, the way instructions and assessment are being conducted has changed. Training and testing have shifted "from the traditional centralised, global, classroom-teacher focused approach, to a de-centralised, global, network based, student focused one" (Federico, 2000, p.360). The developed E-learning program included "Hints and Tips for Reading Hypertexts", a simple introduction to reading skills and instructions how to comprehend hypertext effectively. Also, five sessions containing hypertexts with text, picture and audio links along with sets of reading comprehension tasks enable assessment of students' understanding of material. There is no doubt that this E-learning program will not only supplement traditional classroom teaching but also bring a lot of advantages to students with different learning styles and their teachers.

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