Mark-UP: Facilitating Reading Comprehension Through On-Line Collaborative Annotation

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Abstract This paper describes the theoretical foundation, design philosophy, and development process for a product to assist in the development of students' cognitive self-regulatory skills when engaging in reading activities at a tertiary level. *Mark-UP* is an on-line tool, developed using MySQL and PHP and delivered in an OS X server environment, to facilitate students' engagement with academic texts. Students annotate, discuss, and add resources to on-line readings within a pedagogical framework of reciprocal teaching, designed to promote metacognition and develop students' independent skills in reading and understanding academic texts.

Introduction

As tertiary education evolves to provide greater flexibility and improved economic outcomes through more efficient means of delivery, one obvious use of the Internet is as a means of accessing course readings, either in the form of web pages or as electronic documents, such as PDF resources. The approach of providing several electronic readings rather than a single text also promotes the multiple perspectives inherent in contemporary approaches to learning such as those espoused in cognitive flexibility theory (Spiro, Feltovich, Jacobson, and Coulson, 1992). However, it is erroneous to assume that students entering tertiary education are able to engage effectively in readings in a self-regulated way. There is a difference between learning to read and reading to learn. Most students have little difficulty with the building blocks of reading such as phonics, but even by Year 12, studies have shown that only 40% of students can be identified as 'proficient' at the level of reading that involves engagement "in higher level, problem solving literacy of the kind required in an information generating and information transforming economy" (Greenleaf, Schoenbach, Cziko, and Mueller, 2001, p. 83). This paper outlines the design and development of on-line learning environment created to promote students' self-regulation of reading comprehension

Metacognitive Self-Regulation of Reading Comprehension

Self-Regulation can be seen as a combination of both cognitive and affective components. Students need a high level of self-awareness, both of their existing understandings and self-concept. Underpinning these are the processes of self-monitoring and motivation activated and exemplified by volitional and cognitive strategies (McMahon and Oliver, 2001). This

“fusion of skill and will" (Garcia, 1995, cited in Brooks, 1997, p. 139) is the key to students effectively being able to monitor their performance and develop strategies to enhance it. But while there is a large body of research, which examines ways in which the affective components of self-regulation can be targeted to increase students’ motivation and persistence in their learning, cognitive aspects are generally seen as less accessible. As the primary enabling state for cognitive self-regulation, metacognition in particular is a concept that is fraught with contention. Some have argued that it is an inherent psychological state that cannot be changed, though recent research is suggesting that the acquisition of metacognition may be subject to instructional intervention (Boekaerts, 1997). The question then becomes one of how cognitive self-regulation can be promoted in an on-line environment.

In fact, a number of general features are claimed within the literature for what characterises effective environments for metacognition. Blakey and Spence (1990) cite Dirkes’ synthesis of much of the literature on metacognition into the following features:

- Connecting new information to former knowledge.
- Selecting thinking strategies deliberately.
- Planning, monitoring, and evaluating thinking processes. (Dirkes, 1985).

The first two features are predominantly influenced by the outcomes defined for a specific course or unit of instruction. The third involves the internalisation of the learning towards self-directed practice. It is in providing the means to facilitate the planning, monitoring, and evaluation inherent in metacognitive learning that the challenge lies. Grabinger (1996) for example cites the following strategies:

- 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.

Another set of suggestions are as follows (Blakey and Spence, 1990):

- Identifying “what you know” and “what you don’t know”.
- Talking about thinking
- Keeping a thinking journal
- Planning and self-regulation
- Debriefing the thinking process
- Self-evaluation

Reading Comprehension as a Metacognitive Activity

Dole, Duffy, Roehler, and Pearson (1991) synthesised the research on Reading Comprehension to identify the following regulatory strategies that are inherent in the skill.

- Determining importance

- Summarising information
- Drawing inferences
- Generating questions
- Monitoring comprehension

While at one level they involve defined activities, they are also general regulatory strategies that can be applied to any text within the skill of Reading Comprehension. The key, then, is now to identify the supports, activities, and resources necessary to promote the metacognitive use of these.

Palinscar and Brown (1984) propose an approach to teaching Reading Comprehension called Reciprocal Teaching. In this theory, there are three main components to supporting learning:

- Dialogue between students and teacher, each taking a turn in the role of dialogue leader
- "Reciprocal" interactions where one person acts in response to the others
- Structured dialogue using four strategies: questioning, summarising, clarifying and predicting

Inherent in these components is the concept of dialogue and reciprocation. Learners take on the roles of teachers as well as learners, and learning takes places through a process of discussion, and negotiation. It is this which provides the support necessary for self-monitoring to take place. What makes it pertinent to metacognitive self-regulation is that it is an approach, which while initially structured, and teacher driven has the ultimate goal of moving from guided practice through the gradual release of responsibility to students' independent development and use of such strategies (Duke and Pearson, 2002). The activities of Questioning, Summarising, and Clarifying and predicting can offer a gateway to the strategies inherent in reading comprehension. Obviously, however, it is not merely the practice of such strategies that will develop the self-regulatory use of them.

Rosenshine and Meister (1994) ally reciprocal teaching with three particular approaches to support: the zone of proximal development (Vygotsky, 1978); proleptic teaching (Wertsch and Stone, 1979); and scaffolding (Wood et al, 1976). Proleptic teaching specifically has learners as 'apprentices' who 'as they become more experienced and capable of performing more complex aspects of the task … modelled … time and time again, they are ceded greater and greater responsibility until the become experts themselves' (Brown and Palinscar, 1989, p. 410). As the name suggests, scaffolding involves the provision of supports that are geared towards a student's particular capacities (within their zone of proximal development) and are removed as the learner develops the ability to perform tasks independently. In this sense it has been argued that such approaches are similar to other forms of guided practice (e.g. Hunter, 1982; Good and Grouws, 1979) but in Reciprocal teaching emphasis is placed on encouraging students to provide instructional support for one another, instead of simply relying on the teacher as coach and mentor (Rosenshine and Meister, 1994). Scaffolding procedures include "reducing complexity to manageable amounts, marking critical features, and demonstrating solution when the learner can recognise them" (Rosenshine and Meister, 1994).

Mark-UP

These tenets have been integrated into the on-line environment *Mark-UP*. This environment promotes the development of metacognitive strategies for reading comprehension through a process of scaffolded reciprocal teaching.

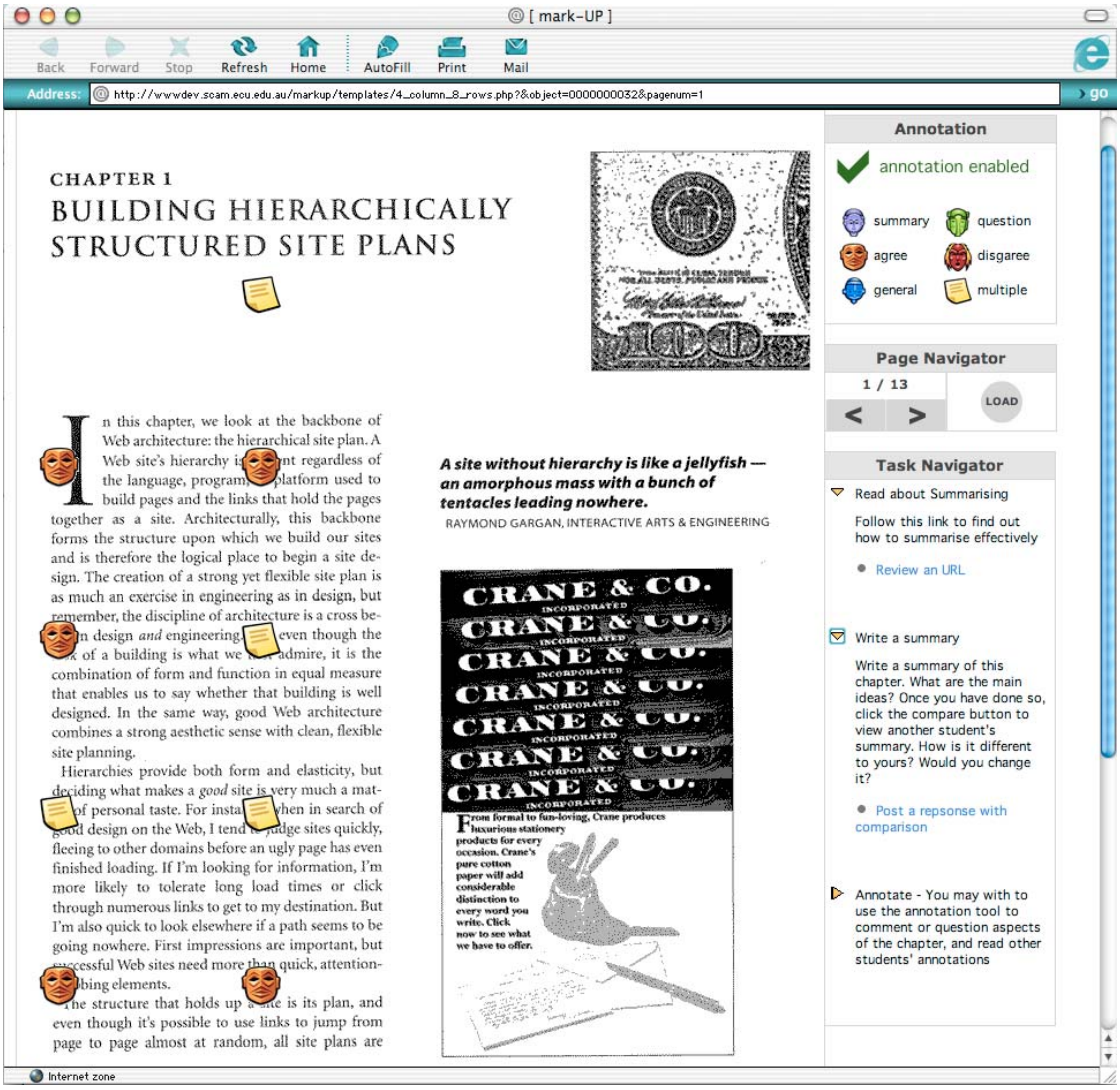

Figure 1: Mark-UP

As can be seen (figure 1), the reading forms the basis of activity within the environment, and a visual context to the learning that takes place. Students engage in tasks relating to the reading that require the use of a specific set of tools to share ideas about the artefact. These tools are described below (Table 1).

Tool	Description	Rationale
Links	Users can add a link to an external website, including a title and comment. Other users add a comment to an existing link and rate the give it a star value (0-5) The course designer can also comment on and rate a link as well as add one (make admin clear to users)	This tool can be used to have students reflect on their interpretation of a specific reading by finding a website that covers a similar topic, and then discuss the similarities and differences in points of view. The ability to rate other students' links, and compare perspectives, as well as receive those of the course designer provides the reciprocal teaching for the self-monitoring processes in which learners engage
Annotations	Users click on a part of the reading to add an annotation to it, which then appears as an icon on the screen at the point where they annotate. Annotations take the forms of: • Agree and Add a comment/example • Disagree and give reasons • Seek other comments with prompt questions • Summarise a section in your own words • Predict the progression of the discourse Each type of annotation is represented by a different icon. Learners can view each other's annotations and add to them. The course designer can also add annotations	This tool is used to have students engage in the regulatory strategies for reading comprehension as proposed by Dole et al. (1991). Support for self-monitoring is provided by the discussion with peers as well as comments modelled by the tutor.
Focus Questions and Activities	The course designer can pose questions and provide a text box for users to complete. Questions may take many forms, for example prompts about a reading, or instructions for the end user to provide concrete examples	This is a generic tool that allows handling of information types not supported by links and annotations. For example, end users may be required to summarise a whole reading, or identify key ideas within it. Also it provides an opportunity for users to evaluate their progression over a period of time and review previous work to identify their conceptual growth. For example a student may be required to articulate a theory as it has been informed by a reading. Later in the semester, they may be required to compare that position in the light of new information that is provided.
Discussion Boards	This is a direct link to an on-line discussion board. The user can start a thread of discussion or respond to an existing one	The discussion board tool is one common to many on-line learning environments. In this case, it accommodates discussion that is not tied to a specific section of a reading but may be more general in nature. It allows the course designer to create and respond to student issues as well as peer collaboration
Portfolio Generator	Portfolios consist of a summary of all the students' work. They can be organised by topic or by type of activity such as links, annotations, focus question responses etc. Students generate their portfolio which they can further edit before submission. The course designer also has the ability to collate all of the students' work in portfolio form.	The value of journaling as a means to enhance self-awareness is well documented (Brooks, 1997). The portfolio has a role as a summative assessment, but most of all it provides an information base for further reflection. Students may be required to review their understandings as articulated within the portfolio to describe how their understandings have developed.

Table 1: A summary of the tools within Mark-UP

Development Process

The initial challenge for the development of *Mark-Up* was to identify technologies that could manage the delivery of readings, while at the same time provide the flexible work environment for the collaborative negotiation inherent in the reciprocal teaching model for reading comprehension.

Table 2 shows a sample of the technologies investigated in ascending order, with the experimentation beginning in July 2002 and finishing in December 2002. The initial explorations focused on the Portal Document Format (PDF) as the document delivery method.

Product	Experimentation summary
Macromedia Director 8.0, deployed as a Shockwave movie, using PDF xtra (Integration New Media).	Although the PDF xtra provided adequate support for PDF documents within the shockwave environment, including auto-downloading of the xtra, it only provided limited support for Macintosh OS 9 clients, and no Mac OS X support. As the final product was to be deployed in the Mac OS X environment this solution was excluded.
Macromedia Director 8.0 using html member.	This model used html pages that were imported into a shockwave movie for display. This model was excluded, as the documents would have to be converted into HTML format, and the html support with Director 8.0 was limited to the HTML 3.2 standard.
Macromedia Flash 5.0 using XML objects.	This model required that all the documents would have to be converted into an XML format.
Adobe Acrobat 5.0 Review and Commenting tools.	Acrobat's webDAV enabled review and commenting feature facilitated all the necessary interactions required by a user when reviewing a document but did not allow for the authored comments to be transferred into a database system. This restricted the usefulness of the comments, as they could not be used outside of Acrobat. The review and commenting feature is only available in the full version of Adobe Acrobat and at present there is no native version of Acrobat for Mac OS X.
Adobe Acrobat 5.0 using embedded forms submitted to FileMaker Pro 5 and MySQL 3 databases.	This model pre-defined regions on each page within the PDF document. The regions were hidden form elements that the user clicked on which called a JavaScript function. The function then submitted the form data, including the user information, to a backend database. This model worked in practise but did not facilitate any method for bringing in the comments back into the PDF document. This meant that the user could not view their annotations in their proper context.
PHP enabled web based system using MySQL Database.	PHP enabled web pages that use a combination of DHTML, XML, and Flash. This model gave the highest flexibility in design and uses large format, 8bit graphics of the document pages.

Table 2: Design explorations.

The final system design incorporates many of today's leading technologies, including FLASH, XML, LDAP, PHP, DHTML and MySQL all implemented with Macintosh OS X operating system as the development and delivery environment. This decision was based upon the prevalence of OS X as the client base but also because it provides an excellent development base, and comes pre-installed with open source technologies, such as the Apache web server, PHP, Tomcat, MySQL, and LDAP.

MySQL was chosen as the database back-end having proven itself with an estimated 4,000,000 customers worldwide (MySQL, 2003). As an open source technology it provides a huge support base of developers and it our situation, 100% uptime.

PHP is another open source technology that offers developers an incredibly large amount of programming tools for deployment of the web. A recent survey found 12,000,000 domains using php-enabled websites since January 1999 (PHP, 2003). PHP has enabled *Mark-UP* to be truly dynamic application, with support enabled for MySQL and PostgreSQL databases, PDF generation, XML, XSLT, and LDAP

A key component of the *Mark-UP* system is its flexible nature of its design, in both the database back-end, and the php-enabled front-end.

The flexibility of the back-end MySQL database system can be best described in outlining the main table relationships. Each table has been designed with a parent — child relationship, meaning that each table (child) contains the unique identifier of its predecessor (parent). This recursive design meant it is very easy to "attach" new tools to the *Mark-UP* system. This model is demonstrated in the figure 2 below, which shows the table structure of the annotation system.

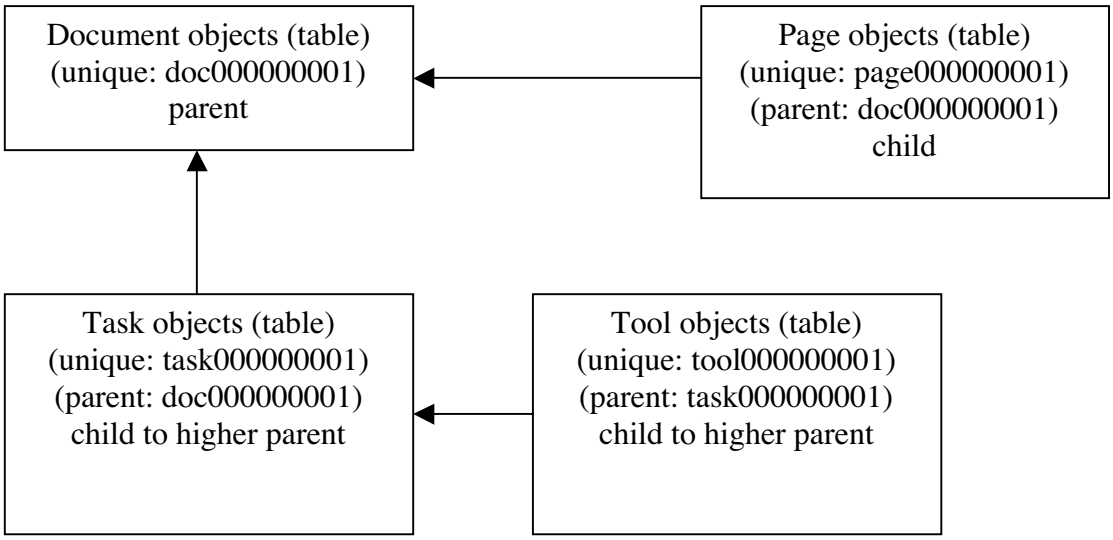

Figure 2: MySQL table structure for annotation system.

The above table relationship allows new tool objects to be created easily and attached to existing documents, or document tasks without having to modify the existing data. Examples of the tool objects include Annotation, Links, Discussion Boards and the Portfolio Generator.

Another key feature of *Mark-UP* is its ability to transform the annotation model depending on the type of document being reviewed. The facilitator of the system can create a document template file using an online form by specifying the amount of *Mark-UP* regions needed on the page. The document is broken up into a grid, based of the number of regions specified, which students click on to attach comments to a particular area of the document.

In another situation the *Mark-UP* facilitator could change the system to support online assessment, online marking, or online reading comprehension exams by simply uploading a test, marking guide, or reading document, then create a template file to match. All this is carried out online by the *Mark-UP* facilitator and does not require any programming changes.

Conclusion

The development of *Mark-UP* has necessarily been constrained by the functionality of the available development tools. Adobe's Acrobat document format is widely used in educational environments to deliver course readings. While an excellent approach to compressing printable documents as well as providing some annotation tools, however, its limitations as a shared online annotation environment made it unsuitable to the purposes of promoting self-

regulation. A generic PHP solution instead provided the flexibility for the collaborative work environment and the ability for the generation of students' portfolios necessary to support the reflective process inherent in the development of self-regulatory skills for reading comprehension.

Given the claim that those "who are poor at self regulation easily can be slaughtered in WWW-based courses" (Brooks, 1997, p. 135) and the high drop-out rate for students with poor study skills when they venture on-line (Loomis, 2000), the need for such a tool is paramount. Contemporary approaches to education seek to empower to the learner rather than 'teach' the learner through a traditional learning approach based on knowledge transfer (Jonassen and Land, 2000). This is a frequently cited focus of on-line learning, where students are expected to engage in academic texts with typically little or no direct instruction on their comprehension (Reeves and Reeves, 1997). This is a difficult task however for many students. Research shows that metacognitive knowledge and self-regulation facilitate reading comprehension (Collins, Dickson, Simmons, and Kameenui, 2001) but this is an end-product rather than a process. One cannot assume that simply placing students in a mode of study that requires self-regulation will help to promote it. Rather than throw students 'in at the deep end', mechanisms must be in place which bridge the nexus between supported and self-regulated learning.

Mark-UP is one approach to provide such a mechanism through the generic, portable, and above all stable framework of PHP and MySQL within a Mac OS X server environment. Currently in its initial beta trials, it is already being implemented in a unit at Edith Cowan University, where students are using it to annotate, discuss, and review readings in Instructional Design. By the time of publication some initial data should be available to assess the value of *Mark-UP* as a tool to assist in the self-regulation of reading comprehension.

References

[1] BLAKEY E. AND SPENCE S. (1990) *Developing Metacognition ERIC Digest*. Retrieved 19 January, 2002, from http://www.ed.gov/databases/ERIC_Digests/ed327218.html

[2] BOEKAERTS M. (1997) *Self-Regulated Learning: a new concept embraced by researchers, policy makers, educators, teachers, and students* Learning and Instruction **7** (2) 161-186.

[3] BROOKS D. W. (1997) *Web Teaching: A guide to designing interactive teaching for the World Wide Web.* New York: Plenum Press.

[4] BROWN A.L. AND PALINSCAR A.S. (1989) *Guided, cooperative learning and individual knowledge acquisition* in L. B. Resnick (Ed.), *Knowing, learning, and Instruction: Essays in honour of Robert Glaser* (393-451). Hillsdale, N. J.: Erlbaum.

[5] COLLINS V. L., DICKSON S. V., SIMMONS D. C. AND KAMEENUI E. J. (2001) *Metacognition and Its Relation to Reading Comprehension: A Synthesis of the Research*. Retrieved 9 January, 2002, from http://idea.uoregon.edu/~ncite/documents/techrep/tech23.html

[6] DOLE J. A., DUFFY G. G., ROEHLER L. R. AND PEARSON P. D. (1991) *Moving from the Old to the New: Research on Reading Comprehension Instruction* Review of Educational Research, **61** (2) 239-269.

[7] DUKE N. K. AND PEARSON P. D. (2002) *Effective Practices for Developing Reading Comprehension*. Retrieved 17 December, 2002, from http://ed-web3.educ.msu.edu/pearson/pdppaper/Duke/ndpdp.html

[8] GRABINGER R. S. (1996) *Rich Environments for Active Learning* in D. H. Jonassen (Ed.), *Handbook of Research for Educational Communications and Technology* (665-691). New York: Simon and Schuster McMillan.

[9] GREENLEAF C., L., SCHOENBACH R., CZIKO C. AND MUELLER F. L. (2001) *Apprenticing adolescent readers to academic literacy* Harvard Educational Review **71** (1) 79-127.

[10] JONASSEN D. H. AND LAND S. M. (Eds.) (2000) *Theoretical Foundations of Learning Environments*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

[11] LOOMIS K. D. (2000) *Learning Styles and Asynchronous Learning: Comparing the LASSI Model to Class Performance* Journal of Asynchronous Learning Networks **4** (1) 23-31.

[12] MCMAHON M. T. J. AND OLIVER R. (2001) *Promoting Self-Regulated Learning in an on-line environment.* Paper presented at the Ed Media 2001, Tampere, Finland.

[13] PALINSCAR A. S. AND BROWN A. L. (1984) *Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities* Cognition and Instruction **1** 117-175.

[14] REEVES T. C. AND REEVES P. M. (1997) *Effective Dimensions of Interactive Learning on the WWW* in B. H. Khan (Ed.), *Web Based Instruction* (59-66). Englewood Cliffs, New Jersey.

[15] ROSENSHINE B. AND MEISTER C. (1994) *Reciprocal Teaching: A Review of the Research* Review of Educational Research **64** (4) 479-530.

[16] SPIRO R. J., FELTOVICH P. J., JACOBSON M. J. AND COULSON R. L. (1992) *Cognitive Flexibility, Constructivism, and Hypertext: Random Access Instruction for Advanced Knowledge Acquisition in Ill-Structured Domains* in T. Duffy and D. H. Jonassen (Eds.), *Constructivism and the Technology of Instruction*. Hillsdale, N.J.: Erlbaum.