INVESTIGATING THE IMPACT OF LEARNING FROM HYPERMEDIA

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ABSTRACT

Distance education via the internet is now one of the most viable options for delivery of information to people in different places and because of this the concept of hypermedia is gaining in popularity. In the healthcare field it is crucial to reach people and update their knowledge in their area of expertise due to the direct impact this has on quality care. However, it is not enough to simply have the information available on the internet without supporting the learning process. The information must be presented in such a way that it can be easily updated as new information becomes available and be designed in such a way that the course objectives are met, with demonstrable improvement in knowledge. How people learn becomes then a crucial issue for delivering this information successfully to the target audience. Hypermedia is a methodology that allows for learner control, different ways of navigating and searching, and multiple perspectives and is best suited for learners with good metacognitive strategies. How is it then possible to support all learners metacognitively in a hypermedia learning environment? This review paper focuses on the following: a) learning from hypermedia environments, b) the design of hypermedia programs, and c) he metacognitive issues that arise in using hypermedia for education. The review concludes by proposing a study to investigate how a computer-based metacognition training regimen impacts learning from a hypermedia course and how metacognitive strategies are being utilized. The hypermedia course is on Type 2 Diabetes and Children/Adolescents, an issue that is gaining more attention as obesity in children and adolescents is rising.

KEYWORDS

Hypermedia, metacognition, computer-based learning, diabetes

INTRODUCTION

With the advent and expansion of the World Wide Web (WWW) the interest in and use of hypermedia for instruction and training is growing. Distance education via the WWW is now a viable option for the delivery of information to a large number of people located in different places. In the healthcare field it is crucial to reach people and be able to update their knowledge in their area of expertise, since there is a direct impact to quality care. The term hypertext was defined by Ted Nelson in 1965 as non-sequential writing and hypermedia as an extension of hypertext that includes video, audio, and graphics. Since then the definition of hypermedia has evolved and is defined by Park (1992) as the organization of different types of multimedia information that is easily accessible, retrievable, and modifiable and can be used as an instructional delivery system, an idea generation and organization tool, file storage and information system, and/or a computer-based instructional authoring tool. As many learners do not have or know how to utilize learning strategies, it is not enough to simply have the information available without features to support the learning process. Therefore, in designing instruction using hypermedia methodology, meta-learning features should be in place to support learning strategies and help learners improve their learning. Learning strategies are strategies that students use in their learning process to manage it or "learning how to learn" (Weinstein & Mayer, 1986).

How people learn is a crucial issue for instructional designers for delivering content successfully to the target audience and utilizing the appropriate methodology. Hypermedia is now a common methodology for many distance education courses delivered through the WWW. It is important to note that not all web-based courses are hypermedia courses and certainly hypermedia courses do not need to be web-based. The critical aspect for designers is to promote active learning to enhance student engagement in their learning process. One of the main elements of active learning is the ability to self-monitor one's learning. Methodologies such as hypermedia that allow learners more control over their learning process can be very useful in the promotion of active learning.

Hypermedia is, in fact, being used as an instructional method in diverse areas such as continuing and professional education classes, university courses, and vocational training. Organizations such as the Pan American Health Organization have incorporated virtual universities offering courses in many health issues. Established universities such as The George Washington University in Washington DC offer online distance education programs in health sciences and for continuing medical education (CME) credits. However, using hypermedia for instructional purposes is not an easy task. In hypermedia environments with web-like structures, research has shown that learners tend to get disorientated, impacting negatively on the learning process (Dillon & Gabbard, 1998) and it seems that this may be more of an issue for novice users (Altun, 2000). It then follows that making students metacognitively aware, that is being able to utilize good learning strategies, assess the quality of their learning and find ways to improve it, becomes an important, if not an essential, feature of hypermedia programs. Therefore, the characteristics of the learners themselves in terms of their metacognitive abilities and prior knowledge come into play. Comprehension monitoring strategies or metacognition/metacognitive strategies are defined by Weinstein & Mayer (1986) as "students' knowledge about their own cognitive processes and their ability to control these processes by organizing, monitoring, and modifying them as a function of learning outcomes."

METACOGNITION AND LEARNING

Flavell (1979) defined metacognition as "knowledge and cognition about cognitive phenomena." There are two aspects of metacognition, knowledge about cognition (declarative, procedural, and conditional) and regulation of cognition (planning, monitoring, and evaluation) (Schraw & Dennison 1994, Schraw, 1998). Metamemory, metacomprehension, self-regulation, schema training, and transfer have been identified in the literature as the sub-components of metacognition (Osman & Hannafin, 1992). Metacognition depends on an individual's knowledge of his/her abilities and strategies that could potentially improve learning as well as the regulation of the individual's thinking that draws from his/her knowledge of cognition (Hartley, 2001).

Field-independent users seem to learn more effectively than field-dependent users of hypermedia programs (Weller et al 1995). In their review, Dillon and Gabbard (1998) suggest that ability and willingness on the part of the learners to explore may be an indicator to how well they utilize the hypermedia environment and suggest that passive learners may be more influenced by cueing of the necessary information. Also, motivation may be a factor impacting metacognition that has not been given much attention in the literature (Schmidt & Ford, 2001).

"Metacognition is especially important because it affects acquisition, comprehension, retention and application of what is learned, in addition to affecting learning efficiency, critical thinking, and problem solving. Metacongitive awareness enables control or self-regulation over thinking and learning processes and products" (Hartman, 1998).

In terms of performance, high metacognitive skills are associated with success and low skills with failure. "Students with effective metacognitive skills accurately estimate their knowledge in a variety of domains, monitor their ongoing learning, update their knowledge, and develop effective plans for new learning" (Everson & Tobias, 1998). It is therefore, necessary to find ways to enhance learners' metacognition so that learners are better able to monitor their learning process by utilizing good learning strategies.

HYPERMEDIA AND METACOGNITION

Research has shown that effective learners have superior metacognitive skills; compared with average learners, they are more aware of their strengths and weaknesses and are therefore better able to improve their own learning skills (Bransford et al., 1999). The metacognitive process helps learning by guiding a student's thinking and by helping the learner follow a wise course of action in thinking through a problem, attempting to understand a situation, or making decisions (NCREL, 1995). Jones et al. (1995) concluded that if the learner's awareness of metacognitive knowledge can be improved then the efficacy of learning could be enhanced. Collaborative learning, as a teaching strategy, has also been hypothesized to improve metacognition through modeling and tutoring. In fact, Dillon and Gabbard (1998) suggest that hypermedia programs can offer ways to better the performance of less able students through, for example, explicit cueing. It is necessary to identify how these can be best designed and it is also important to incorporate instruction on why and when to use learning strategies (Osman and Hannafin, 1992).

Research on metacognitive skills suggests that such skills can be directly trained and can also be fostered by indirectly prompting the learners (Toney, 2000). However, literature reviews have concluded that merging metacognition and hypermedia-based learning has not been accomplished in a consistent and successful manner (Osman and Hannafin, 1992; Lin, 1994). Lin (1994) concluded that "it is not clear either what types of metacognitive training may be effective for specific types of learners given specific topics and learning environments." There is however agreement among researchers that instruction of metacognition can facilitate learning (Hacker, 1998).

As hypermedia methodology is increasingly being used for instruction and training, metacognition is becoming one of the areas of focus by researchers for potentially improving learning. In hypermedia environments the learners direct their learning in order to achieve their learning goals. This requires adequate monitoring strategies that many learners may not already possess and it also requires metacognitive tools. In order to increase metacognitive accuracy, more deliberate instruction may be needed that could be enhanced if educational technology was integrated in the learning process (Ayersman, 1995, Jones et al. 1995). Lin (2001) also emphasizes that it is necessary to "nurture student self-knowledge and domain knowledge simultaneously."

Winne and Hadwin (1998) suggest that self-regulated learning is significantly affected when students use, change, or do not use metacognitive strategies. Unless students are asked to think about their learning through instructional activities, they will not use metacognitive thinking (Bransford et al., 1999; Hartley, 2001). Hartley (2001) incorporated learning strategy instruction in hypermedia learning materials and found that even though the students benefited in terms of the regulation of their cognition, this improvement did not impact achievement nor did it impact their knowledge of cognition. Metacognitive development, that is the integration of the understanding of the new metacognitive skills within the student's existing knowledge, was identified as one of the potential problems for not showing improvement in achievement or in knowledge of cognition (Hartley 2001). There is a need for better integration between strategy and content instruction, as well as application of what is taught (Harley, 2001; Park, 1992).

Lanza and Roselli (1991) examined the effects of a hypertextual and structured approach on achievement. In their study they found no significant differences on performance between the two groups however they noted that the hypertextual approach group had more variability in its scores. Hypermedia environments for instruction may be more applicable for more independent, motivated, and higher ability students (Lanza and Roselli, 1991).

Lindner and Harris (1992) developed a working model on self-regulated learning and an inventory to test metacognition, learning strategies, motivation, contextual sensitivity, and environmental utilization/control. There was a significant correlation between the scores on the sub-scales and the student GPA. This provides support for the importance of the relationship between self-regulatory skills and successful academic performance. Therefore; providing adequate metacognitive training may be what is needed.

It seems that research on metacognition has focused on topics such as on how learners use their metacognitive skills, how accurately they do so, and what supports may be needed to enhance their skills. In order for students to be better able to work with hypermedia, the development of metacognitive monitoring skills needs to also be emphasized and incorporated as part of a hypermedia-based course as this has been suggested as a potentially useful method (Zimmerman 1998).

DESIGNING HYPERMEDIA PROGRAMS

As research indicates that learners with weak metacognitive skills are not as successful in guiding or adequately monitoring their learning, it is therefore important to enhance learners metacognitive strategies especially when using hypermedia programs. Barba (1993) looked at the effects of using an instructional map in a hypermedia course. An instructional map is defined as "externally supplied graphic organizer embedded in courseware and used to provide the learner with feedback on his/her progress" (Barba, 1993). The findings from the study did not show significance on student achievement from use of the embedded map however, it is suggested that teachers should instruct their students on utilizing meta-learning strategies to improve their performance (Barba, 1993).

A study by Lee et al. (1997) looked at the effects of concept maps and metacognitive cues in a hypermedia program on genetics and the results from the concept maps and the metacognitive cues groups were significant when compared to the control group. However, using both concept maps and metacognitive cues together did not result in higher achievement. Although metacognitive cues were effective the students reported that the cues were distracting. Lee et al. recommend the use of these techniques in science programs and they call for further research "to better understand the circumstances under which metacognitive cues may successfully be employed in hypermedia learning environments."

Implementing a detached metacognitive strategy training approach and comparing it with embedded supports may be a more effective approach. Detached training are domain-independent, isolated courses that train for example, study skills utilizing generic instructional materials, while embedded training integrates the training into the instructional materials (Clark, 1988). A combined approach of embedded and detached is recommended by some researchers (Clark, 1988, Derry & Murphy, 1986) while others propose a more integrated approach (Hartley, 2001, Cardinale & Smith, 1994).

Problems in learning with hypermedia programs include disorientation and cognitive overload. Much of the research has focused on tools used while browsing through hypermedia environments such as keyword searches, concept maps, analytical searches guided tours and guidance tools, and 3-D graphical browsers (Beasley & Waugh, 1996). The purpose of this line of research is to lead to more effective hypermedia interfaces. It is suggested in the literature that when learners are made aware of the structural aspects of a hypermedia program disorientation decreases (Beasley & Waugh, 1996). Ayersman and Reed (1998) examined the relationships between hypermedia-based mental models (concept maps, semantic networks, frames, schemata), knowledge of hypermedia, and task types and found that students with more hypermedia knowledge seem to cite more frequently nonlinear models and concluded that indeed hypermedia students need experience before using nonlinear hypermedia structures. Providing students with training on metacognitive strategy use in hypermedia environments could potentially prove helpful for students with different hypermedia knowledge.

In his review of hypermedia design and research, Tergan (1997) reports results from research that suggest that learners are not able to learn successfully structured knowledge from environments that are unstructured. The structure of hypermedia programs allows learners to make choices about which links to follow on a given page and more importantly what content to choose to see which can be problematic for learners with lower metacognition. As a result, important aspects of the content area in the hypermedia program may be missed making it difficult to compare learning from hypermedia. Quentin-Baxter and Dewhurst (1992) developed a method to look at the efficiency of presenting information and find out which cues were preferred by the learners for navigation and potentially learning. Some of the factors identified by Quentin-Baxter and Dewhurst are listed below:

- Amount of time to use the program
- Organization of information and how it is linked
- Type of interactive method (browsing or directed) used by the student
- Ability to learn from the user's knowledge and experience.

This last factor, ability to learn from user's knowledge and experience may affect the learners' ability to use the hypermedia program and may be linked to the amount of information accessed (Quentin-Baxter & Dewhurst 1992). Therefore, a metacognitive strategy training could enhance the learners' ability to learn from their own experiences.
There are several models that have made significant contributions to the design of instructor-independent programs (Table 1). It is therefore critical that metacognitive processes are taken into account in designing instruction especially in hypermedia learning environments due to the increased learner control.

Other design considerations for the hypermedia program include the following:

- Suggesting learning goals and learning strategies, and requiring learning activity products (Cates 1992, Grabinger & Dunlap, 1996)
- History list (nodes visited) (Cates, 1992; Grabinger & Dunlap, 1996; Kommers, 1996)
- Overview maps and diagrams (Grabinger & Dunlap, 1996; Kommers, 1996)
- Guided practice (Hsu et al., 1994)
- Records (Grabinger & Dunlap, 1996)
    - Detailing learning process and strategies used
    - Sequencing
    - Progress

Table 1. Metacognition Models

Models	**Model**
COPES model of metacognitive monitoring and control (Winne & Hadwin, 1998)	*Factors* Student expertise in subject matter Degree to which student is active metacognitively Addresses four stages of studying: • Task Definition • Goal Setting and Planning, Enacting • Study Tactics and Strategies, and • Metacognitively Adapting Studying
Theoretical framework of self-regulated learning. (Dunlonsky & Hertzog, 1998) *This framework has been used in memory-training programs for older adults and can be a useful guide for any metacognition training program.*	*Factors* Both metacognitive and cognitive components Addresses the following: • task preparation, • ongoing study, and retrieval.
The Nelson-Narens (1990) framework.	*Factors* Metamemory monitoring control issues

	Addresses the following: • knowledge acquisition (in advance of learning, on-going learning), • retention (maintenance of knowledge), and • retrieval (self-directed search, output of response). Examples of monitoring strategies (judgments of learning, confidence, etc.) and of control such as allocation of study time and selection of search strategies.
Self-regulated learning model (Lindner & Harris, 1992)	*Factors* Regulation of cognition knowledge about cognition, and self-reflective awareness Addresses the following: • Metacomprehension in terms of text processing and listening skills and • Metamemory in terms of general strategy knowledge, acquisition procedures, and specific strategy knowledge
Metacognitive framework (Lin, 2001) *The proposed framework by Lin conceptualizes metacognitive activities as more than just domain skills and building knowledge about the self as a learner.*	Addresses the following: • Instructional approaches ("strategy training" and "creating social support"), and • content being taught ("domain –specific" and "knowledge of self as learner").

CONCLUSION

There have been studies on training metacognition that suggest that this is an effective approach in improving achievement and transfer (Volet, 1991). Determining individual differences in metacognition has also been a challenge (Schwartz & Metcalfe, 1994). Toney (2000) identifies the following limitations to research on metacognition:

- the inconsistency of the results in studies that have tried to directly train metacognitive skills
- the inconsistency in operationalizing metacognition
- no direct connection in theory or research between metacognition, seeking behaviors, and training outcomes.

Appendix 1 describes some of the instruments available for assessing metacogntion that have recently tried to deal with operationalizing metacongition. Gavelek and Raphael (1985) also discuss the methodological concerns regarding appropriate measures for assessing metacognition. They identified the following questions:

1. Does an individual give evidence of monitoring and/or regulating his or her cognitive performance?
2. Is this individual's performance facilitated as a result of such activity?
3. Does the individual engage in the metacognitive activity across multiple settings?

These are important questions and indeed it is crucial that research studies try to address them. It seems evident from this review that there is a need to develop ways that would support and improve learners' metacognitive skills so that they can become more effective self-directed learners. Once this is achieved it should follow that learners will also be more effective when using hypermedia programs.

In conclusion, the author proposes a study to address Gavelek's and Raphael's (1985) three questions (above) as well as Hartley's (2001) recommendations for further research in an integrated approach between strategy training and content. The study will incorporate metacognitive training implemented prior to the hypermedia course on diabetes and also include embedded metacognitive supports in the hypermedia program itself (Zimmerman 1998, Hartley 2001, Tergan 1997). This proposed study (underway) is also meant to facilitate the participants' performance and to investigate the degree to which the participants are engaging in metacognitive activities in the hypermedia course.

APPENDIX

Metacognition Instruments

MAI (Schraw and Dennison, 1994)	52-item inventory to assess metacognitive awareness in adults. The results from the two experiments indicate that the Metacognitive Awareness Inventory (MAI) is a reliable instrument of metacognitive awareness in adults/older students and that it could be a useful tool in the planning of metacognitive training as well as identifying students with monitoring problems. In Experiment 1, the MAI measured knowledge of cognition and regulation of cognition reliably. Experiment 2 was done to validate the MAI. The MAI measured knowledge of cognition and regulation of cognition reliably. The MAI does not measure distinct sub-components of metacognition (Declarative knowledge, Procedural knowledge, Conditional knowledge, Planning, Information Management Strategies, Monitoring, Debugging strategies, Evaluation).
State Metacognitive Inventory (O'Neil Jr. and Abedi, 1996)	20 items, with 5 items for each of four sub-scales identified (planning, monitoring, cognitive strategies, and awareness). This measure is intended to be a useful indicator for educational goals that emphasize work habits and/or metacognitive strategies. Operational definition: "periodic self-checking of whether one's goals are achieved and selecting and applying different strategies." In their study, they found the instrument to be robust for 12th grade and above.
KMA (Tobias et al., 1999	The Metacognitive Knowledge Monitoring Awareness (KMA) was designed to assess knowledge monitoring and can be applied to in many different content domains and for different student populations. The KMA is an assessment procedure that obtains knowledge estimates and then compares them to test performance. The discrepancy between the two is the index of knowledge monitoring accuracy.

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