Self-regulation and Hypermedia: Undergraduate Students’ Self-regulation in Hypermedia Learning Environments

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Abstract

Recent widespread use of hypermedia in education may be challenging to some learners because of information overload, technical novelty, and multiple levels of decision making, requiring their more self-regulatory learning ability. In scaffolding learners to be more self-regulated, it would be critical to expand our understanding about how learning with hypermedia relates to self-regulation. This paper reviews major theories of self-regulation and discusses recent research findings and their implications for facilitating undergraduates’ self-regulated learning with hypermedia.

Introduction

Learning with hypermedia has the potential to help learners’ understanding of complex knowledge because it enables learners’ flexible, dynamic, and non-linear access to a wide range of information represented as text, graphics, animation, audio, and video (Jacobson & Archodidou, 2000; Jonassen, 1996). In addition, hypermedia allow learners’ control over access, and this increased control may motivate learning (Dillon & Gabbard, 1998; Kinzie, 1990; Steinberg, 1989).

Despite these benefits of learning with hypermedia, interacting with hypermedia may be challenging to some learners, particularly novice learners in an academic domain, because of information overload, technical novelty, and required multiple levels of decisions making. These difficulties of hypermedia integrated learning probably require a more strategic learning ability from learners. According to Zimmerman (1989), self-regulated learning occurs to the degree that a student can use personal process, such as goal settings, self-efficacy perception, and metacognitive process, to strategically regulate behaviors in the immediate learning environment. Therefore self-regulated learners are goal-oriented, and tend to monitor their academic performance to evaluate their own progress against the learning goals or objectives.

In a hypermedia learning context, learners have to frequently decide which content to branch and what scope to limit the content. Therefore, it is important to help learners promote their cognitive and metacognitive control over their learning that is characterized by the behaviors of planning, monitoring, and evaluating their own learning process. However there seems to be lack of understanding about how learners can learn effectively in such environments (Azevedo & Cromley, 2003).

In respond to this need for expanding our understanding about effective learning and instruction with hypermedia, this paper discussed on theoretical assumptions of self-regulation and the function of self-regulation in various hypermedia learning contexts. Additionally recent research findings were overviewed and their implications for facilitating undergraduates’ self-regulated learning were discussed.

Theoretical Foundations

Self-regulation

Learners are self-regulated to the degree that they are metacognitively, motivationally, and behaviorally active participants in their own learning process (Zimmerman, 1986). According to Zimmerman (2001) self-regulation involves awareness of the potential usefulness of self-regulation processes in enhancing their academic achievement, monitoring of the effectiveness of learning methods and strategies, and responding to this feedback either perceptually or behaviorally. Self-regulation also entails self-evaluation of capabilities and progress in information acquisition, which is judged against their own goals or standards (Schunk, 2004).

Concerning how and why students choose to use particular self-regulated process, strategy, or response, there are different theoretical perspectives. From the behaviorally oriented view, all self-regulated learning responses are under the external control of reward or punishment contingencies; from the cognitive perspective, students are motivated primarily by a sense of self-esteem or self-concept; from the social cognitive perspective, effective self-regulation demands goals and motivation.
Information Processing Perspectives

From the information processing perspective, learning is a set of processes by which we acquire information (Winne, 2001). Information is processed in three locations: sensory register, working memory, and long-term memory. Once the new information received through the sensory register is attended to and perceived, working memory processes the input by rehearsing or associate it with information in long-term memory. Since working memory is very limited in capability and duration, information is organized and encoded in a way to accommodate retrieval in long-term memory. Long-term memory forms network of nodes and links of chunks of knowledge.

We can retrieve information back to working memory through spreading activation (Anderson, 1991). A knowledge unit in long term memory is connected to other knowledge units relevant to it forming a knowledge network. When a knowledge unit is activated, it spreads to all the other units connected to it. Metacognitive monitoring and control involve all steps of the memory process; attention, perception, encoding, and recall. Over the memory process, metacognition plays a critical role in regulating acquisition of information. Metacognition has been simply defined as thinking about thinking (Hacker, 1998). According to Flavell (1976), metacognition is “knowledge and cognition about cognitive phenomenon” (p.906) and involves deliberate, intentional, and goal-directed mental operations. Metacognition occurs through actions and interactions among four components: metacognitive knowledge, metacognitive experiences, goals, and strategies.

Hacker (1998) described four components of Flavell’s Metacognition: 1) Metacognitive knowledge including a learner’s stored world knowledge, their cognitive tasks, goals, strategies for achieving them, actions, and experiences; 2) metacognitive experiences including one’s awareness of his cognitive and affective process and how the progress toward the goal of a current process is being made; 3) Adaptation of metacognitive knowledge in response to the metacognitive experiences; 4) Adjustment of the goal or the strategies to be used to accomplish the goal. From Flavell’s view, self-regulation is metacognitive control over the learning process.

On the basis of the information processing perspective, the four phases Self-Regulated Learning (SRL) model was recently introduced (Winnie and Hadwin, 1998; Winne, 2001). The SRL model includes four components: conditions, products, standards, and evaluations. Conditions refer to resources available for work on a task and constraints that may affect information process. Among the resources, the most significant resource is considered prior knowledge. The second component, products, is new information created when information is processed. Successive products build toward the goal, which may reside in memory or in the environment as overt outcomes. The third component is standards (goals) that current learning processes are judged against. The final component is evaluations, which are made by the monitoring process.

All components go through four phases: 1) Defining the task, 2) setting goals and planning, 3) enacting tactics, and 4) adapting metacognition. In the defining the task phase, the learner processes information about the conditions that characterize the learning task. In the setting goal and planning phase, the learner frames a goal and specifies plans to approach it. In the enacting tactics phase, the learner applies tactics and strategies that were identified in the setting goal and planning phase. In the adapting metacognition phase, the learner makes major adaptations to their schema that structure how self-regulating is carried out.

Constructivist Perspectives

Vygosky’s zone of proximal development (ZDP) strongly influences self-regulation. ZDP is defined as “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under guidance or in collaboration with more capable peers” (Vygotsky, 1978, p. 86, cited by Schunk, 2004). In the ZDP, an adult with expertise and a learner work together on a task that the learner could not perform independently because of the difficulty level (Schunk, 2004).

Instructional scaffolding refers to the process of controlling task elements that are beyond the learners’ capabilities so that they can focus on and master those features of the task that they can grasp quickly (Burning, Schraw, & Ronning, 1999). In this approach, a teacher provides support, and gradually fades aid as the learners acquire the skill and control of their own learning.

Implicit theories bring a new perspective to self-regulation. Learners construct theories about self-regulated learning (Schunk, 2004); therefore self-regulation is highly contextualized (Paris, Byrnes, & Paris 2001). Learners can formulate theories about what contributes to success in performing different tasks (Schunk, 2004). Self-regulatory strategies that the learners bring to their learning might be either effective or misleading. Learners might believe they are capable of learning some tasks or they might doubt their ability to complete them. The ideas underlying implicit theories suggest that it is important for educators to understand what beliefs and feelings that the learners initially have about their own learning of specific tasks so that any instructional intervention for self-regulated learning is adjusted to the needs of individual learners.
Goal Orientation and Self-regulation

In addition to learner’s beliefs and needs, learners’ goal orientation can also affect what and how learners approach learning material. The type of goal that a student adopts may impact the student’s perception of progress, self-efficacy, and self-evaluation (Schunk, 2004). Researchers have identified two different goal orientations, task-mastery and performance goals. Task-mastery goals focus students’ attention on processes and strategies that help them acquire knowledge, behaviors, skills, or strategies. On the other hand, performance goals direct students’ attention to completing tasks. Research supports that pursuing task-mastery goals enhance intrinsic motivation and active cognitive involvement characterized by self-regulatory activities (Meece, Blumenfeld, & Hoyle, 1988).

Hypermedia and Self-regulation

Hypermedia learning environments enable either linear or non-linear presentation of knowledge. Knowledge presented in a non-linear fashion allows learners to navigate freely from one concept to another, without concern for predetermined order or sequence (McManus, 2001). Linked structure of hypermedia may accurately represent the associative network that makes up the human memory and may allow realistic representation of expert semantic network (Jonassen, 1993). Semantic networks and concept maps represent the structure of the information within the hypermedia environments (Reed & Steven, 1995). However, the knowledge representations that learners construct from hypermedia may be incomplete resulting in misconceptions or misunderstanding, unless the learners are provided with additional modeling or instruction about the knowledge structure is provided.

Additionally the non-linear trait of hypermedia learning environments lets the learners control the organization of the information (Liu, 1992). Thus the learning situations with more control and options involve multiple levels of decision making, probably requiring higher level of ability to control learning processes from the learners.

As referred in the previous section, regulating learning involves learners’ metacognitive awareness of their learning process. Metacognitive awareness is possible when the learners have conditional knowledge, knowledge about when and how to use declarative or procedural knowledge relevant to a given learning task. Conditional knowledge allows learners to metacognitively monitor their learning progress toward their learning goals and evaluate the effectiveness of their learning process against the goals. The self-regulatory learning process in hypermedia environments seems to be a dynamic process involving interaction among learners’ self-regulatory ability, learners’ prior knowledge, traits of hypermedia, and the learning tasks. While monitoring their learning processes with hypermedia, learners change or revise their learning strategies or tactics to make their learning more effective. This also implies that research can be designed taking into account interaction of such diverse factors.

In the following review, special attention was paid to determining how the studies handled those factors relevant to self-regulation in hypermedia learning environments and what the findings about the relationship among those factors are, and what their findings imply for helping self-regulatory learning. The studies included in this review were selected because they all related to undergraduates’ self-regulatory learning with hypermedia.

However, the included studies do not exhaust all studies pertaining to undergraduates’ self-regulatory learning in hypermedia learning settings.

Current Research on Self-regulation and Hypermedia

Hypermedia environments can provide learners with more freedom to control pace, order, and sequence of learning (Liu, 1992), with more autonomy, some learners in hypermedia environments may feel disoriented or less efficacious. Learning with hypermedia would be challenging especially to the learners who have less domain knowledge. In deriving implications for effective instruction for learning with hypermedia, current research appears to focus on addressing two dominant aspects: 1) relationship between the feature of hypermedia and self-regulation and 2) the effects of various scaffolds on promoting self-regulation ability and learning. Thus, this paper reviewed several studies that were thought to dominantly address those two aspects. The included studies were issued from 2001 to 2005 and all relate to learning with hypermedia of undergraduates who were novices in a content domain.

Non-linear Structure of Hypermedia and Self-regulation

When the demands that a task creates on a learner are high, or the task is complicated, the learner’s working memory is overloaded, leaving little and sometimes insufficient resources to apply to self-regulating (Zimmerman, 2001). Particularly in hypermedia learning environment, the cognitive load that the non-linear structure of hypermedia may impose on learners would be a great concern.
Eveland and Dunwoody (2001) tested if hypermedia learning environments bring higher cognitive load than traditional print-based learning environments. In this study, levels of cognitive load were conceptualized as being directly consistent with the variation of non-linearity in the Web. Different levels of media conditions, control, print, linear web, non-linear web and advisement web, were compared on the performances of recognition and cued recall respectively as measuring of learning. Motivation, web expertise, and self-reported cognitive load were taken into account as covariates. The result revealed that learning was greater for print than the web conditions on recognition performance indicating probably lower cognitive load in the print condition than other media conditions. To the contrary, there were no significant differences across media conditions on the recall performance. As expected, self-reported cognitive load negatively predicted the recall performance. Based on the findings, the author suggested that there was evidence to support the claim that hypermedia presentations may reduce learning compared to traditional print because of such factors as cognitive load (Oliver, 1996) and disorientation (Calvi, 1997; Darken & Sibert, 1996; MacDonald Stevenson, 1996). The result from the self-report about cognitive load also confirmed that non-linear feature of hypermedia could be an obstacle to self-regulatory learning requiring learners’ extra cognitive efforts of navigating from a part of content to another. However, this finding is not conclusive because there might be other important variables that could influence learning. For example, learners possibly perform better because of their prior knowledge about the content (reading text) rather than different media conditions.

In this study the prior knowledge about the content of interest was not directly measured across the conditions. In addition, the failure in finding any difference among various media conditions on recall measuring might be because variation of the level of linearity across different media conditions were not be optimally established to determine any dissimilarity among them. Another possibility is that the reading material might not actually be differed in the level of freedom of control over navigation across various media conditions. As the author indicated, the perceived overload and actual cognitive overload are possibly unlike.

While Eveland and Dunwoody (2001)’s study focused on the feature of hypermedia and learning, McManus (2000) examined a more direct relationship between the non-linear structure of hypermedia and self-regulation. This study examined how non-linearity and an advance organizer together relate to self-regulation and learning. The results illuminated two types of interaction; one was the interaction between non-linearity and self-regulation (p=0.054), and the other was the interaction between non-linearity and advance organizer (p=0.052). It was suggested that highly self-regulated learners learn poorly in mostly linear hypermedia learning environments where they have very few choices, while medium self-regulated learners learn less in highly non-linear environments where there are too many options. The results also suggested that an advance organizer is more effective in highly non-linear web-based hypermedia than in mostly linear learning environments.

The results from the McManus (2000)’s study implied importance of adapting hypermedia to learners’ self-regulation ability. A diagnosis of learners’ self regulation ability should precede designing a learning unit with hypermedia. Additionally, repeated diagnoses of the learners’ progress in their ability to regulate learning as well as assessment made prior to implementing a learning unit would be necessary particularly when learners’ consistent change is anticipated. For example, if a part of the learning goal is learning about hypermedia technology itself, the learner will need less scaffolding or guidance as their expertise grows with the on-going use of the hypermedia. The non-linearity of hypermedia would become less of a cognitive load with time.

The variation of self-regulation may be associated with the ways the learners navigate hypermedia in a particular manner. Sweany (2000) attempted to determine if the particular pattern of hypermedia navigation interacts with strategic learning. This study investigated what the emerging patterns in undergraduate students’ navigation behaviors are and how they are associated with strategic learning while the learners interact with material including a CD-Rom and the Internet designed for an introductory French course. For the navigation cluster analysis, the log files were automatically recorded while the students were using the computer in the class, and analyzed. Goal orientation, instrumentality, and metacognitive self-regulation were regrouped as a strategic learning variable. It was anticipated that combination of strategic learning and a particular pattern in using computer features would have the highest relationship with achievement.

This study revealed that students’ achievement differed with the ways they navigate hypermedia. Based on these findings, it was suggested that strategic learning might mediate the relationship between hypermedia navigation and achievement. As the author noted, not all students will automatically use hypermedia programs effectively. Therefore, it would be important to help learners to be more strategic in using hypermedia integrated learning contexts. Furthermore, navigational design should be considered prior to integrating hypermedia into the classroom.

Puntambekar and Stylianou (2005) similarly attempted to examine the ways that students navigated through hypermedia. Although the study did not target undergraduate subjects, the study seems to provide insights into learning with hypermedia across diverse levels of subjects. The study found the positive effect of metacognitive
navigational scaffolding on students’ understanding of organization of information and suggested that the metacognitive prompts reminded students of the goal and encouraged them to reflect on their decisions they made for seeking information. In a hypermedia system a student constantly makes decisions about which link to visit next and about what piece of information is relevant to their current goals of learning. Thus, it would important for readers to monitor and regulate both their comprehension and navigation strategies (Puntambekar & Stylianou, 2005).

There is also empirical evidence that learners perceive metacognitive structural cues distracting rather than helpful (Lee et al., 1997). Processing metacognitive scaffolds may take additional cognitive efforts from learners, therefore adding more cognitive load rather than promoting learning. As a result, in designing navigational support tools, it should be considered how to minimize the demands from such structural cues.

An issue raised from this study was the potential mediation of the students’ prior knowledge on the content topic of interest. The navigational behaviors may be associated with the student’s semantic organization of their existing domain knowledge. If this is the case, how should hypermedia semantically intervene individual domain knowledge in such a way that further learning occurs more effectively with hypertext? A particular issue would be how to tailor self-regulatory monitoring support to different students and when is the right time for providing it (e.g., providing whenever asked by the learners or automatically after certain amount of time has past)?

**Effective Scaffolding of Self-regulation**

The studies previously reviewed indicated that learners might be cognitively overloaded or disoriented with the non-linear structure of hypermedia. Additionally, it was suggested that goal-based navigation and navigational scaffolding intended to promote metacognitive monitoring of navigational behaviors enhanced learning in the hypermedia learning environments. In the following section, how self-regulatory scaffolding learning with hypermedia influences self-regulation and learning were reviewed based on recent findings.

Debowski, Wood, and Bandura (2001) examined the impact of guidance over search of electronic database on self-regulation. In this study, self-efficacy, satisfaction, and internal motivation were conceptualized as major predictive factors for self-regulation on the student’s performance. It was found that the guided search mode of electronic database was more effective than the self-guided search mode in developing post-training self-efficacy and satisfaction; however, intrinsic motivation was not affected by exploration modes. The guided search mode included instruction on the order for completing database searching tasks, reminders of the steps to follow in developing a strategy for each task, and modeling of responses that followed problems and mistakes in the use of strategies during practice. On the other hand, in the self-guided (or enactive) search mode the sequence of tasks, the steps in the strategy process, and the responses to problems were left to the discretion of the individual searcher. It was revealed that guided search produced higher levels of perceived self-efficacy, satisfaction, strategy quality, and performance and a lower level of wasted effort on electronic search tasks than self-guided search did. The author concluded that self-enactive learning would be most effective when structured tasks are given to learners who have greater expertise on dynamic tasks along with more informative feedback. Among theorists, goal setting and planning were considered as critical stages for self-regulated learning. Social cognitive theorists claim that self-set goals promote self-efficacy. Azevedo et al. (2002) examined how the different instructional goal setting conditions influence students’ learning of complex science concepts with hypermedia based on the SRL model (Winnie et al., 1998; 2001). The SRL model explains learners’ recursive cycles of control and monitoring during the four phases of learning: perceiving tasks, setting goals and planning, employing tactics, and enacting tactics.

In this study forty undergraduates were randomly assigned to four different goal setting conditions: the bottom-up condition, the learner-generated sub goal condition, the strategy instruction condition, and the co-regulation condition. The pre- and post-tests comparison group design with a think-aloud methodology was used. It was revealed that both the co-regulation (with tutor’s guidance) and strategy instruction conditions facilitated students’ learning. The data from all conditions were analyzed over the five main SRL categories: planning, monitoring, strategy use, handling task difficulty and demands, and interest. Findings revealed that the co-regulated goal setting condition promoted learning of complex science contents. In the co-regulation condition, the tutor assisted learners in regulating their learning by using various strategies, scaffolding their learning, and intervening when they asked for assistance. The tutors helped the students plan sub-goals, monitor their cognitive processes, and provided feedback.

In the subsequent study, Azevedo and colleagues (2003) examined the effectiveness of adaptive scaffolding on self-regulated learning. The subjects were assigned to one of three conditions: adaptive content and process scaffolding (ACPS), adaptive process scaffolding (APS), and no scaffolding (NS) and were trained to use a hypermedia environment to learn about the circulatory system. In the adaptive scaffolding condition, students could access a tutor who provided scaffolding to help with their content understanding (content scaffolding) or self-
regulated learning process (processing scaffolding). Based on the analyses from the pre-and post-tests, and verbal protocol data, the author reported that the adaptive scaffolding, both ACPS and APS, facilitated learning more than NS. An interesting finding from the data was the differences of self-regulatory behaviors while learning between the two adaptive conditions. Participants in the ACPS condition regulated their learning by engaging in help-seeking and over-relying on the tutor to regulate their learning. While, participants in the APS condition regulated their learning by planning and monitoring their emerging understanding, and handled task difficulties well.

In summarizing the studies conducted by Azevedo and his colleagues, it was suggested that scaffolding learners’ use of self-regulation strategies in hypermedia learning environments is critical. In addition, such scaffolding would be most effective if adapting to learners’ individual needs in controlling their learnt process. However, the scaffolding should not be in excess because support exceedingly provided may ruin the learners’ desire to be active in controlling their learning process. How learners’ prior content knowledge is associated with use of self-regulation strategies still remains to be examined in future studies.

The use of the SRL strategies has been suggested to be context dependent. Whipp and Chiarelli (2005) found that students adapted their use of self-regulation strategies to the unique feature of the web-based learning environment. Paralleling this finding, the study conducted by Dabbagh & Kitsantas (2005) discovered that learners facilitated or withdrew their intention to use SRL strategies in accordance to the unique features of learning environments. In this study it was determined that in distributed (blended) learning, students differed their use of self-regulation process depending on the types of web-based pedagogical tools provided.

Self-regulation is suggested to be particularly important in distributed learning settings because the students are often asked to complete tasks with limited interaction and support from the instructor and peers (Kauffman, 2002; Whipp & Chiarelli, 2005). Distributed, or blended, learning situations as rich hypermedia learning contexts, involves such features as enabling access of information, navigation through content links, web-links and information spaces, and the use of search engines (Dabbagh & Kitsantas, 2005).

Dabbagh and Kitsantas’ study investigated how different categories of Web-Based Pedagogical Tools (WBPT) integrated into a Web-CT course management system (CMS) supported different SRL processes. Additionally, they attempted to determine students’ perception of the usefulness of WBPT in evoking the SRL processes. The findings indicated that content creation and delivery tools supported the SRL processes of goal setting, help seeking, self-evaluation, and task strategies. While collaborative and communication tools (e.g., email and discussion forum), content creation delivery tools (e.g., tools for uploading contents and assignments and tools for students to access course resources and readings) supported goal setting, time planning and management, and help seeking. Administrative tools (e.g., tools to manage general course information and functions; and student information, and interactions) supported self-monitoring, self-evaluation, time planning and management, and help seeking while assessment tools (tools for announcing or tracing student progress) supported task strategies, self-monitoring, and self-evaluation.

Based on the qualitative analysis it was suggested that when engaging students in problem solving tasks in distributed learning environments, content delivery tools should be used to provide a variety examples or sample solutions to enhance students’ self-regulatory learning. The qualitative results also revealed that the students perceived that content creation and delivery tools, especially the reading, resources, and assignment/rubrics features, were useful in scaffolding help seeking and self-evaluation while completing assignments involving dialogical learning tasks. The author suggested that when engaging students in articulation and reflection required in on-line discussions, content and delivery tools should provide relevant resources and allow an on-line access to the readings. Additionally providing students a rubric of how they will be evaluated was considered to be important in scaffolding the SRL process of self-evaluation.

Other implications derived from the findings included that a group discussion area should be provided to facilitate help seeking, time planning, and time management. It also found that a space to post working drafts should be provided to support evaluation and task strategies. A rubric should be available to help students’ goal setting, and an access to resources should be made available to support the help seeking process. Students perceived that administrative, assessment, and collaborative and communication tools (e.g., e-mail and discussion features tools) were useful in time planning and time management, and self-monitoring.

However, the findings from Dabbagh and Kitsantas’ study may be applied restrictedly to a web-based course that includes face to face interactions and also uses a CMS tool similar to Web-CT. Also, learners’ self-report about use of WBPT is probably dissimilar to their actual use of WBPT. The study did not follow students’ actual use of WBPT in terms of frequency; therefore, it was impossible to validate students’ self-report with behavioral data.

Choi, Land and Turgeon (2005) tested the effect of a scaffolding tool on self-regulatory learning in a totally on-line learning context. This study attempted to determine if scaffolded peer questioning in on-line discussion
facilitated metacognition and learning. Meaningful verbal interactions and generating adapted feedback require a
certain level of domain and metacognitive knowledge from a questioner. A learner in a new domain is often limited
in domain and metacognitive knowledge; therefore they can neither ask the right questions nor generate constructive
feedback (Land, 2000).

This study used a time-series control-group design. The study included and conducted in online
introductory class targeted learning for turf-grass management with thirty nine undergraduates as the subjects. The
results showed that there was a significant effect of use on frequency of peer-generated questions. However the
peer-questioning scaffolds did not improve the quality of questions. The effect seemed to be dependent on the type
of a question. The dominant portion of the peer generated questions was clarification/elaboration questions, which
was defined as “questions seeking additional information to clarify or elaborate learners’ initial ideas”. Thus the
findings were limited in generalizing other types of questions, such as counter-arguments (peer-generated ideas
expressing disagreement with learners’ initial ideas, which could address cognitive conflicts) and context- or
perspective-oriented questions (hypothetical questions changing critical factors in a given problem situation or
considering different perspectives on the problems). Further research may concentrate on how to develop more
effective peer-questioning scaffolds to address diverse types of questions.

In general, findings from Choi and colleagues’ study indicated that fixed (as opposed to dynamic) scaffolds
were useful to increase the frequency of student questioning behavior during online discussion. Further studies may
want to focus on the quality improvement of peer-generated questions using dynamic and adaptive scaffolding. As
the author addressed how those factors (prior knowledge, metacognition, task complexity, and scaffolding type)
interact in an online learning context would be an important research task in the future.

**Conclusion**

The studies reviewed in this paper shared the idea that despite of the usefulness of hypermedia because of
its ability to display knowledge in a non-linear way, hypermedia integrated learning may be challenging to novice
learners in a content domain. Therefore, learning with hypermedia may require higher self-regulation ability from
learners. The findings from the studies included indicated that learners’ self-regulatory ability interacts with the
feature of non-linearity of hypermedia. In addition, the ways that learners use their self-regulation ability with
hypermedia is highly situational; some of those variables that probably interact with personal variables in
hypermedia learning were support from teachers and peers, teachers’ attitudes, characteristics of content or tasks,
and instructional strategies intended to guide informational organization (e.g., navigational or organization clues). It
was also strongly suggested that individualizing scaffolding for the students’ regulation over their learning is critical
to promote self-regulated learning. Although results from the studies reviewed need to be further tested, a few
important implications for designing instruction in hypermedia learning contexts were addressed.

First of all, the findings implied that there were positive relationships between the level of non-linearity of
hypermedia and cognitive load (Eveland and Dunwoody, 2001) and metacognitive navigational scaffolds was useful
in reducing the cognitive load. As opposed to the traditional learning settings where content is provided in a linear
order and often the teacher decides what sequence the learners follow to complete a task, learners in hypermedia
learning contexts themselves should deal with the non-linearity in terms of the organization of content and the
sequence for completing a task. Thus, learners need to be more strategic to metacognitively monitor their decisions
for paths in relation to the learning goal. Particularly the studies conducted by Puntambekar and Stylianou (2005)
and McManus (2000) indicated that metacognitive scaffolds such as navigational prompts and advanced organizers
were effective for students’ understanding of organization of information and goal-oriented navigational behaviors.

Another important implication for designing instruction integrating hypermedia was that when instructional
strategies such as an advance organizer or navigational clues are employed as scaffolding tools, the level of non-
linearity of content organization and learner’ ability to regulate their own learning should be taken into account as
the major concern. According to McManus (2002), not all learners seem to benefit from such scaffolds as advanced
organizers. The study showed that highly self-regulated learners learn better in highly non-linear environments
where there are many options of paths. On the other hand less self-regulated learners perform better in relatively
linear hypermedia learning environments with few options of paths. This suggested that designing a course
involving hypermedia should be adapted to individual level of self-regulation. The study also suggested that an
advanced organizer is more effective in a highly non-linear hypermedia environment than in a mostly linear learning
environment. As mentioned in the previous section, this implies constant diagnoses of self-regulation ability of
learners should precede designing a course to include hypermedia. Additionally it would be important to encourage
students to monitor their understanding and use of self-regulatory strategies by frequently prompting the learning
goals.
However, the potential mediation effect of students’ prior knowledge, such as goal orientation, instrumentality, and metacognitive self-regulation as Sweany (2000) determined, on students’ navigational behaviors and learning still remains to be examined. The navigational behaviors may be associated with the student’s semantic organization of their existing domain knowledge. If it is the case, how to semantically intervene individual domain knowledge in such a way that further learning occurs more effectively with hypermedia should be considered. In addition there is empirical evidence that learners perceived metacognitive structural cues were distracting rather than helpful (Lee et al., 1997). Therefore, when including a navigational support tool necessary for learners’ understanding of information, it should be considered how to minimize cognitive demands from such structural cues while maintaining the benefits from those tactics. Particular issues addressed were how to tailor self-regulatory monitoring support to different learners and when the right time is for providing it (e.g., providing whenever asked by the learners or automatically after certain amount of time has past).

From the studies conducted by Debowski et al (2001) and Azevedo et al (2002; 2003), another important implication for designing instruction with hypermedia was addressed. The studies implied that guidance and informative feedback from tutors and teachers about how to regulate learning was effective for learners’ planning their goals, monitoring their emerging understanding, and using effective strategies. The studies also indicated that there is a positive impact of guidance on learners’ self-regulation in hypermedia environments. Guided search (Debowski, Wood, & Bandura, 2001) produced higher levels of perceived self-efficacy, satisfaction, strategy quality, and performance over self-guided search. A suggestion was that self-enactive learning is more effective when the learners are more trained in using hypermedia, the tasks are structured enough, and more informative feedback is provided to the learners. The informative feedback given by a teacher or tutor is critical for the learner to be more strategic in their learning. Simply knowing how to use strategies does not guarantee that students will use them, therefore it is important to help learners to formulate effective strategies for their learning (Schunk, 2004) with hypermedia. Instructional methods and educators’ attitudes both possibly appeared to influence learner’s self-regulation in hypermedia environments.

Research also suggested that self-regulation is context dependent (Whipp & Chiarelli, 2005). As more undergraduate courses integrate World Wide Web, or become web-based, learners have been situated in a hypermedia intensive learning context. In a rich hypermedia learning environment such as web-based or distributed courses, learning can be efficient in that learning can occur while students are separated by time and space from other students or the instructor. However, students may be misled if they do not know how to regulate in accessing resources and seeking information to complete learning tasks because they are often given little or very limited support from other learners or the instructor. Research showed that in distributed or web-based learning environments, different types of web-based pedagogical tools facilitated learners’ enactment of different self-regulation processes (Kitsantas & Dabbah, 2005).

The findings from the studies carried out by Dabbagh & Kitsantas (2005) and Choi & Turgeon (2005) implied that teachers may decide what specific type of web-based pedagogical tools to include and how to provide it, in accordance to the learning goals, the nature of assignments, and the aspects of self-regulation targeted to promote. Also, the result from the qualitative analysis implied that when engaging students in problem solving tasks in distributed learning courses, content delivery tools should be used to provide a variety examples or sample solutions to enhance students’ self-regulatory learning. The analysis also indicated that content creation and delivery tools, especially the reading, resources, and assignment/rubrics features, were useful in scaffolding help seeking and self evaluation while completing assignments involving dialogical learning tasks. Additionally it appeared to be important that when engaging students in articulation and reflection required in on-line discussion, content and delivery tools should provide relevant resources and also allow an online access to the readings. Providing students a clear rubric of how they will be evaluated it was also indicated as important in scaffolding the SRL process of self-evaluation.

A bit differently from the Dabbagh & Kitsantas ’s study, which is conducted in a blended mode of learning context including face to face interactions, Choi and colleagues(2005) conducted a study in a totally on-line learning setting. It was revealed that the fixed (as apposed to dynamic) scaffolds for peer questioning were useful to increase the frequency of student questioning behavior during on-line discussion. However the guidance did not improved the quality of questions. The findings suggested that further studies may want to focus on the quality improvement of peer-generated questions using dynamic and adaptive scaffolding. How prior knowledge, metacognition, task complexity, and scaffolding type interact in on-line learning contexts was considered to be an important future research task.

Finally, it is notable that the findings from the studies reviewed in this paper are limited in being generalized to all type of hypermedia learning contexts. The findings are considered to be context specific in terms of the degree of task difficulty, the level of linearity or non-linearity of hypermedia, the type of support ( personal or non-personal, and fixed or dynamic), and the type of delivery mode (on-line, off-line, or both). Therefore an
application of the findings should be cautiously made considering the details of the educational context in which the referred study is situated. Another limitation was addressed from those studies that examined the association between navigational behaviors through hypermedia and learning. All studies included could not highlight the influence of learners’ prior content knowledge on hypermedia and self-regulation. Navigational behaviors determined in those studies might be mediated by learners’ semantic organization of prior knowledge about the content domain of interest. Some researchers (e.g., Chen & Rada, 1996) suggested that spatial ability may be predictive of learning from hypermedia. Further studies may want to investigate how personal variables such as prior knowledge and spatial ability relate to navigational behaviors and self-regulated learning.

References


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