INFORMATICA, 1994, Vol. 5, No. 1-2, 3-30

HYPERTEXT AND LEARNING: AN OVERVIEW

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Abstract. Despite the vast and rich panorama of hypertext research, to date there are still no clear definitions of what hypertext really is. Classical references describe the concept "hypertext" as a non-linear way of thinking, reading, and accessing the information which is best done on the computer screen. This paper shows the present situation where hypertext is seen as the interaction between the learner and an information source; it raises questions about how information should be organised so as to promote better learning. Due to the fact that the present empirical results still show no consensus among hypertext researchers about the different representations of educational hypertexts; this paper will bring together three perspectives, in particular *traditional, pedagogical* and *psychological* points of view, in order to obtain a coherent view of the current situation in hypertext research. The traditional perspective will outline two main problems that seem endemic to hypertext: problems of navigation and cognitive overload. The pedagogical perspective will summarise the main ideas of three possible theoretical justifications of existing educational hypertexts: the ideas of concept mapping, cognitive flexibility theory, and semantic networking. The psychological perspective will evaluate hypertext from the perspective of human factors (or ergonomics).

Finally, a critical investigation of existing educational hypertexts with consideration of relevant learning theories and human activities will lead to a clearer definition of possible arenas where hypertext might be or might not be an appropriate learning tool.

Key words: hypertext, non-linear learning, navigation, cognitive overload, modern learning theories, concept mapping, cognitive flexibility theory, semantic networking.

Introduction. Despite the vast and rich panorama of hypertext research, to date there are still no clear definitions of what hypertext is. In addition to the fact that every study brings together different opinions and different points of view, there is still no consensus among hypertext designers and researchers about the theoretical justifications for different representations or if there is a need for any theory at all.

Numerous educational hypertexts have been developed, ranging from hypertexts in teaching mechanics, physics, chemistry, biology (Beeman *et al.*, 1987), zoology, engineering, languages, biomedicine (Spiro *et al.*, 1988; Feltovich *et al.*, 1992), law, and architectural design, to hypertexts in teaching psychology (Lehtinen *et al.*, 1993), history (Beeman *et al.*, 1987; Allinson and Hammond, 1989), arts, community information (Baird and Percival, 1989; Edwards and Hardman, 1989), and literature (Landow and Kahn, 1992; Landow, 1990). As a result, many discussions related to various effects on the learning and thinking processes of hypertext readers have been published in recent decades.

Some of the present studies already give theoretical reasons for the design of educational hypertexts. Piet Kommers discusses concept-mapping tools that could be a flexible way of knowledge representation (Heeren and Kommers, 1992), David Jonassen hypothesises about the possibilities to show expert's semantic knowledge structure in hypertext and to "map" it on learner's knowledge structure (Jonassen, 1990, 1993), and Rand Spiro talks about the possibility to achieve advanced knowledge in ill-structured domains with the help of hypertext (Spiro *et al.*, 1988; Spiro *et al.*, 1991; Spiro, 1993).

Various effects on learner's comprehension and activities caused by non-linear learning have become central to evaluation of educational hypertexts. Dee–Lucas and Larkin (1992) examine the review strategies in traditional text and hypertext, Jean–Francois Rouet discusses the cognitive processing (i.e., understanding) of non-linear documents with ideas as to when and how hypertext presentation might facilitate text comprehension and learning activities (Rouet, 1992), and Andrew Dillon studies reading processes from the perspective of ergonomics (Dillon, 1993). As McKnight *et al.* (1993) stated, "the evangelical approach to hypertext has led to many claims of its superiority", but to date many of the experimental comparisons of the media, for example, those of the paper and electronic versions, have failed to demonstrate any clear benefit. According to much of present studies, discussions about hypertext have involved such theories as philosophy, computer science, pedagogy, information science, psychology, and even art, including design.

The aim of this overview is to discuss hypertext according to the classical ideas proposed by hypertext enthusiasts (i.e., Bush, Nelson) and to introduce contemporary more diplomatic approaches, e.g., Andrew Dillon's and Jeff Taylor's. In order to point out the essential effects of hypertext in learning, this study will bring together three points of view: the so-called *traditional, pedagogical,* and *psychological* perspectives.

The *traditional* perspective suggests a discussion about educational hypertexts with hierarchically structured information. Traditional hypertexts usually include an aid to managing a huge amount of information: It could be a menu of possible choices or a content map with appropriate nodes of information and links between them. This perspective is traditional because of the earlier popularity of numerous educational hypertexts that offered management of information

without any theoretical justification for one or another hypertext representation. Consequently, it is possible to hypothesise that two major problems which seem endemic to educational hypertexts, i.e., disorientation (usually called navigation) and cognitive overload, are because of the lack of relevant learning theory.

The *pedagogical* perspective, based on ideas of modern learning theories, emphasises *conceptual learning* (Mayes *et al.*, 1990, 1990a; Mayes, 1992; Kommers, 1992; Heeren and Kommers, 1992; Balcytiene and Lehtinen, 1993), *cognitive flexibility theory* (Spiro *et al.*, 1988; Spiro *et al.*, 1991; Jones and Spiro, 1992; Spiro, 1993; Beeman *et al.*, 1987), and *semantic networking* (Jonassen, 1990, 1992, 1993). Pedagogical perspective deals with modern learning theories that emphasise constructive, cumulative, self-regulated and goal-oriented aspects of learning which are the basis of some modern educational hypertexts (Beeman *et al.*, 1987; Lehtinen *et al.*, 1993; Spiro, 1993).

The *psychological* perspective evaluates hypertext with psychological considerations of human activities such as browsing in a huge body of information, searching for particular information, and reading. These human activities are essential principles for facilitating effective learning (Rouet, 1992; Hammond, 1993; Wright, 1993; Dillon, 1993; McKnight *et al.*, 1993; Whalley, 1990, 1993). As a result, psychological evaluation of existing hypertexts gives a "healthy sceptical judgment" of hypertext itself (Landow, 1990; Whalley, 1993; Hammond, 1993; Dillon, 1993).

Consequently, critical investigation of existing hypertexts and their relation to relevant ideas of learning will lead to a clearer definition of the arenas where hypertext could be an appropriate learning tool.

What is "hypertext"? It has already been six years since the first Association for Computing Machinery (ACM)

Conference on Hypertext brought together researchers, practioners, and users to review the state of the art in hypertext research. In 1987, in the first ACM Conference on Hypertext, Jeff Conklin presented the idea of hypertext as a medium for non-linear organisation of information. According to Conklin's (1987) description, the concept of hypertext is quite simple: A chunk or node of information, for example, a text or picture, is presented on the computer screen and can be easily connected to other chunks in an existing database. Hypertext researchers use the ideas of Bush (1945), Nelson (1990), Conklin (1987), and Halasz (1988) as classical references. Jeff Conklin was the first to give an objective and critical survey of existing hypertexts at the ACM Conference on Hypertext in March 1987. Numerous applications and discussions of hypertext have become increasingly important since that first conference; it is enough to mention educational hypertexts, museum guides, and computer games. As Nelson (1990) has mentioned,

> "I coined the term "hypertext" over twenty years ago, and in the ensuing decades have given many speeches and written numerous articles preaching the hypertext revolution... For years I got the impression that no one had heard or read any of this at all. And now, abruptly, it seems that many people did indeed hear, and many have begun to agree. The strange thing is that all this took so long and then happened so suddenly."

Nowadays many researchers (see Dillon, 1993; Hammond, 1993; Whalley, 1993) admit that original hypertext descriptions and even some of the present ones are rather pompous. In the 1960s Ted Nelson was telling people that "hypertext will be the wave of the future, the next stage of civilization, the next stage of literature and a clarifying force in education and the technical fields, as well as art and culture". Nevertheless, it is true that unlike traditional computer-based instruction

and databases, hypertext systems allow the user to access information by "jumping around" through a series of electronic links, whether in encyclopaedias, textbooks, magazines, newspapers, dictionaries, journals or other resources. By "hypertext" Nelson, who coined the term in the 1960s, means non-sequential writing – text that branches and allows choices to the reader, best read at an interactive screen. As popularly conceived, hypertext is a series of text chunks connected by links which offer the reader different pathways; and is a "form of storage, a totally new form of literature, and a network that might just revitalize human life" (Nelson, 1990). In fact, non-sequential writing on paper can be all sorts of things – magazine layouts, funny arrangements of poetry, pieces of writing and drawing connected by lines, or many other things. As the author enthusiastically notes, all these non-sequential forms of writing will become more possible as we progress in this century from paper to the computer screen. To date, many people still consider these forms of writing to be new, drastic and threatening. Actually, Ted Nelson was the first to take the position that the idea of hypertext is fundamentally typical in any literature, for example, such phrases like "as we have already said", "according to" and "as we will see" are really implicit pointers to the contents of the printed material.

Vannevar Bush's article "As We May Think" (published in 1945) with updated ideas from the 19th century associative network theory has provided a conceptual foundation for the development of hypertexts. According to Bush (1945) and Nelson (1990), hypertext's engine is associative: Users decide the order of information according to their thoughts, and the mechanism of hypertext connects chunks of relevant information into a network of interrelated ideas. An associative data model does not constrain the range of links as much as rule-based engines, and this is the greatest strength of hypertext's philosophy that all enthusiasts, like Nelson, still nourish. Ac-

tually, Ted Nelson was the first to realise early enough that hypertext has a confusing feature, i.e., handling a huge amount of information. The world of paper is different because there objects can be mixed and matched; but nothing similar works with computer systems. Nevertheless, Nelson offers the hope of controlling people's lives:

> "Some people like all this incompatibility and complication, and say it is the new world we must learn to live in. Others, already hating computers, correctly dread these matters and hope vainly to stop the computer tide. I propose a third approach: to unify and organize in the right way, so as to clarify and simplify our computer and working lives, and indeed to bring literature, science, art, and civilization to new heights of understanding, through hypertext." (Nelson, 1990).

Although these ideas were already published several decades ago, but somehow these "holy words" have been forgotten in many of the later studies. Actually, already Vannevar Bush (1945) predicted that "man cannot hope fully to duplicate the processes that take place in his brain, but he certainly ought to be able to learn from it".

Nowadays hypertext theorists have accepted that mechanism of hypertext opperates by association. The philosophy of non-linear reading was developed from the basics of the association psychology of the 19th century; and this powerful model of connecting ideas by associating them has captured the attention of hypertext researchers' from the 1960s to the early 1990s.

Most modern descriptions of hypertext still sound very enthusiastic. They emphasise that connections in hypertext are linked ideas, that hypertext systems offer a direct manipulation with information and lean on the user's spatial reasoning and associative thought (Hardman, 1989), that information is freely viewed, that hypertext systems engage the user as an active participant in interactions with information (Leggett,

Schnase and Kacmar, 1990), that it offers a possibility to organize information in a meaningful and non-linear access, that hypertexts permit learners to determine to a large extent what is studied and the order in which it is read (Dee–Lucas and Larkin, 1992), and that hypertext systems allow the computerized presentation of textual information in a nonlinear, user-controlled fashion (Rouet and Levonen, 1993).

Fortunately, present studies on hypertext are less technology driven, and researchers concentrate more on the effects that hypertext has on readers' thinking processes. On the whole, recent studies are more tolerant of different summaries, for instance, of the healthy scepticism of Landow (1990), Whalley (1990, 1993), Dillon (1993), Taylor (1993), and Hammond (1992, 1993).

Critical interpretations of empirical results have encouraged many researchers (e.g., Jonassen, 1993; Landow, 1990; Whalley, 1993; Rouet, 1992, Rouet and Levonen, 1993; Spiro, 1993; Dillon, 1993; Taylor, 1993; Hammond, 1992, 1993; Wright, 1992, 1993; Lehtinen *et al.*, 1993) to work further to obtain positive findings on the mechanism of educational hypertexts.

Perspective 1: Traditional hypertexts and problems that go together with them. Hypertexts, in general, are computer programs that present chunks of relevant information, which can be text or pictures displayed on a computer screen. The mechanism of hypertext means that the user has to connect two particular chunks of information associatively in order to make the whole computer document usable. In fact, this process is enhanced by the philosophy of hypertext that offers a goal-directed method to information filtering when the learner is guided by his individual choice and preferences. To date, the basic design goal for many hypertexts has been and still remains the same: Users should be able to explore information freely and in multiple parallel

paths, instead of being bound to a fixed path or a predefined structure by one author.

Traditional hypertexts or, as Nick Hammond (1993) calls them, the *basic* hypertexts present information to the learner in the form of a linked network of displays, allowing exploration through browsing. Despite the promising features, particularly those that emphasise the learner's freedom and his choice, experiments in using traditional hypertexts for learning have raised several problems. First, learners get lost because they have no strategies for navigating in large data bases; this becomes the problem of *navigation*. Second, there exists the real danger of cognitive overload, by which Conklin (1987) means the additional effort and concentration needed for the learner to maintain several tasks at one time.

Much previous and recent research has reported that the most common problem is that of the reader's navigation between the chunks of information in the hypertext system (Conklin, 1987; McAleese, 1989; Allinson and Hammond, 1989; Boyle and Snell, 1990; Horney, 1992; Kibby and Mayes, 1990; Jonassen, 1990; Jonassen and Grabinger, 1990, 1992; Mayes, 1992; McKnight *et al.*, 1990; Dillon *et al.*, 1993). Actually, Ted Nelson (1990) mentioned this tricky problem of navigation much earlier. According to him, in books and magazines there are many ways the reader can know where he is (and recognize what he has read before): The thickness of a book, the recalled position of a paragraph on the left or right page, and whether it was at the bottom or the top. Dillon *et al.* (1993) share Nelson's arguments by stating the following: "with books, for example, contents pages are usually at the front, indices at the back and both offer some information on where items are located in the body of the text. Concepts of relative position in the text such as 'before' and 'after' have tangible physical correlates" . It is of no doubt that these incidental cues are important for knowing what readers are doing; yet nothing

similar works with hypertext what means that new cues must be created to take the place of the old ones.

According to McAleese (1989) and to many other researchers on this topic (Hardman, 1989; Edwards and Hardman, 1989), navigation involves the use of a graphic aid such as the map or other visual metaphors (e.g., city and country layouts) to show an overview representation of the existing nodes of information and the connections between them. Many studies have examined the analogies between navigating concrete environments, such as cities or buildings, and navigating data (see Hardman, 1989; Edwards and Hardman, 1989). Usually such studies offer aids to navigation by presenting maps that display the whole network of relevant chunks in hypertext graphically. The basic idea of a map as a spatial metaphor is the assumption that human knowledge is treated as objects stored in specific locations within the mind. Many authors still support the spatial metaphor by suggesting that readers would not be disoriented if they had a conceptual overview or spatial representation of the structure of hypertext. Actually, these visualisation techniques offer the reader a better way of locating information in space: They give ways of accessing information, of knowing where it is. However, they do not in any sense help to navigate in any conceptual space that is essential to thinking processes that are involved in learning.

Even nowadays researchers admit the importance of navigation in hypertexts. According to Dillon *et al.* (1993), "the term "hypertext" evokes many images (e.g., nodes and links, semantic maps, etc.) but perhaps one of the most common is that of users struggling to find their way around a complex information space". Those authors give a psychological perspective to the problem of navigation and its effects on reader's comprehension. As Hardman (1989) has emphasised, very little has been published about the good or the bad aspects of completed hypertexts. It is, however, absolutely clear

that designers of every educational hypertext want to make it as easy as possible for readers to wander around searching for information. Nowadays the goal of many hypertext designers still remains the same, i.e., to ease the browsing in a data base; but other processes, such as the depth of knowledge processing, are taken into consideration as well (Dee–Lucas and Larkin, 1992; Wright, 1993). According to Dee–Lucas and Larkin (1992), minimally structured hypertexts which allow students to demand their own organization of the information may not be suitable when students are gaining an overview of a new topic, but could be used when they have specific tasks guiding their learning. According to Wright (1990), structured maps are task specific and that is why they are such "an excellent resources of help and advice when students have a specific task that is guiding their learning".

In this paper we will not emphasise previous and present researches on various metaphors as tools for navigating hypertexts because the results are not yet satisfactory. All miscellaneous attempts to use graphical aids like maps (Hardman, 1989; Edwards and Hardman, 1989), to analyse styles of hypertext navigation (McAleese, 1989; Horney, 1992), and to explore conceptual navigation (Kommers, 1990; Mayes *et al.*, 1990, 1990a; Boyle and Snell, 1990; Balcytiene and Lehtinen, 1993) have been discussed in the literature. Actually, according to Lehtinen *et al.* (1993), there are reasons for arguing that the main problem in hypertext design is not a technical one: There is a hypothesis that the basic idea behind every hypertext model, particularly the associative and static description of human knowledge and memory, is insufficient when we are developing tools for learning well-organised information and higher order cognitive skills. The belief that knowledge elements and the connections between them could be transmitted into the learner's mind regardless of the learner's activity is questionable. In many learning situations, for instance while

searching for facts in a data base, visual metaphors help because they support information retrieval. Unfortunately, in those situations in which deep conceptual understanding and the active construction of knowledge occur, the metaphors simply lose their meaning because they present the material in the same way as most books do, i.e., in the fixed and "linear" manner. There is a hypothesis that the mechanism of hypertext by itself could be an appropriate tool for information retrieval and data management; but is a poor vehicle for learning when deeper conceptual thinking has to be involved.

The fact that the problem of navigation exists does not mean that hypertext is an unsuitable basis for learning systems. Rather, it needs to be supplemented both by mechanisms (i.e., theoretical justification, see Jonassen, 1992, 1993; Spiro 1993) for helping learners to define their goals; and especially by learning activities for helping learners to achieve these goals (Lehtinen *et al.*, 1993).

Perspective 2: Pedagogical approach and the goal of reading with hypertext. It is generally assumed that learning occurs without an explicit effort to memorise; the more the learner thinks about the material, the better he will understand it. According to Wright (1993), "more" does not mean simply for a longer time but a greater variety of thinking. In fact, the philosophy of hypertext maintains certain key ideas that are essential to modern learning theories, particularly constructive, cumulative, self-regulated, and goal-oriented aspects of learning (Resnick and Klopfer, 1989; De Corte, 1993). As Draper (1992) emphasises, the assumption of using computers/hypertext in education is that they should support conceptual development. On the whole, learning of conceptual material occurs as a by-product of understanding it; and learning is not an optional activity that can be switched on or off independently of comprehension (Wright, 1993). Unfortunately, according to empirical results (McKnight *et al.*,

1990; Dee–Lucas and Larkin, 1992; Jonassen, 1993), hypertext is valuable for information retrieval but not directly for education in the sense of cognitive and conceptual development. Draper (1992) gives an example of phone directories and dictionaries: they are useful in practical contexts, but are not primary means for teaching or learning new concepts. The basis of learning is understanding, not only retrieval of information.

As a matter of fact hypertext applicability as a learning system depends largely upon how it could be used. As Jonassen (1992) stresses, in order to be a learning system hypertext should be thought of as a tool for knowledge construction. The functionality of a hypertext system needs to be acquired by the users so that they could use it to create their own hypertexts that could reflect their own understandings and perceptions. Consequently, hypertext learning system would become a system for learners' to use it as means for determining the meaning of what they would be learning, and for reflecting their understanding in the form that could be useful to them. According to those ideas, educational hypertexts need to extend the learner's intellectual functionality (Jonassen, 1992).

On the whole, educational hypertexts share a common question: Are hypertext users able to manage their own conceptual progression in the information space? From the pedagogical point of view computerized assistance has to do more than just provide additional information: It must trigger effective comprehension processes. According to Jonassen (1992), by navigating through hypertext in individualistic ways, users access information when it is relevant, i.e., when it is best anchored to their knowledge structure. At the same time learners make decisions in navigation; so they are more involved with the learning materials than passive readers of a linear text, i.e., book. Nevertheless, determining the route through the

materials does not distinguish hypertext as a cognitive tool unless it has a relevant theory that is implemented to facilitate hypertext's mechanism, which is originally associative.

The pedagogical perspective offers theoretical justifications, particularly *concept mapping* (Kommers, 1990; Kommers and de Vries, 1992), *cognitive flexibility theory* (Spiro *et al.*, 1988; Spiro *et al.*, 1991; Jones and Spiro, 1992; Spiro, 1993), and *semantic networking* (Jonassen, 1990, 1992, 1993), as three major theoretical guide-lines of information representation in educational hypertexts.

Concept mapping techniques. According to Piet Kommers (1990), a well-known method for stimulating meta-learning is to become aware of conceptual structures, i.e., to visualize the main text concepts and relationships (links) between them. In general, concept mapping is defined as a technique of graphically representing concepts and their relationships. This technique relies on cognitive theories about how humans think, organise and develop their knowledge. By making knowledge explicit, it gives the student the opportunity to explore his/her knowledge and allows the student to monitor his/her process of comprehension (Heeren and Kommers, 1992). Concept mapping tools, like cognitive maps, permit the individual to foresee the locations of information in different places; and this is because of the human imagery that serves to facilitate perceptual processes (Eysenck, 1984).

According to Heeren and Kommers (1992), Kommers and de Vries (1992), Mayes *et al.* (1990; 1990a), cognitive maps in hypertext learning system offer flexible methods of knowledge representation.

Cognitive flexibility theory. According to Whalley (1993), the most significant pedagogic feature of hypertext is its *malleability*; which determines the softness and impressiveness of the idea to organise different chunks of information

into multiple perspectives of a certain domain. *Malleability* of hypertext is essential to the cognitive flexibility theory developed by Rand Spiro and his colleagues (1988, 1991, 1993). According to those authors, this aspect of hypertext is most likely to aid learning.

Cognitive flexibility theory is a theoretical orientation for advanced knowledge acquisition in ill-structured domains; when it is difficult to organise the information in a fixed order, for instance in such domains as biomedicine, literature, history or studies of style (Spiro *et al.*, 1991). The authors of the theory are interested in "advanced knowledge acquisition", that is, learning beyond the introductory stage but before the achievement of practiced expertise that comes with massive experience. In introductory learning the goal is often to establish a general orientation to a field; but "at some point in learning the learners must attain a deeper understanding of content material, reason with it, and apply it flexibly in diverse contexts" (Spiro *et al.*, 1988). Advanced learning involves knowledge which is intertwined and dependent, has significant context-dependent variations, and requires the ability to respond flexibly to "messy" application situations. By domain ill-structuredness authors mean that the meaning of a concept is intimately connected to its patterns of use.

According to Spiro *et al.* (1988), much of the work on computer hypertext systems has been driven by the power of the technology, rather than by a coherent view of the cognitive psychology of non-linear and multidimensional learning and instruction. The characteristic of the cognitive flexibility theory that is implemented in hypertext systems is the understanding of the metaphor of landscape exploration. Deep understanding of a complex landscape, that is an ill-structured domain, will not be obtained from a single traversal:

> "The landscape must be criss-crossed in many directions to master its complexity... The same sites (i.e., concepts) in the

> landscape should be revisited from different directions, and thought about from different perspectives..." (Spiro *et al.*, 1988).

The importance of revisiting and rearranging in the development of multiple representations is targeted for advanced knowledge acquisition in ill-structured domains. It is true that there is no point in imposing an extra cognitive load of a non-linearity and multidimensionality if the domain being studied is simple and well-structured. By repeating the presentation of the same complex case or same complex concept in new contexts, additional aspects of the multifacetedness of the landscape sites are brought out, enabling the kind of rich representations necessary in a complex and ill-structured domain. According to Rand Spiro and his colleagues, single representations (e.g., a single schema, organizational logic, line of argument, etc.) will miss important facets (aspects) of complex concepts. Cognitive flexibility is dependent upon having a changing repertoire of ways of thinking about a conceptual topic. Spiro's main assumption is that knowledge which will have to be used in many ways has to be learned, represented, and tried out in many different ways as well. Consequently, complex concepts can rarely be represented using a single schema or theoretical perspective:

> "viewing nonlineal knowledge from a lineal perspective is somewhat like viewing three-dimensional objects from a two-dimensional perspective. The nonlineal world seems to consist of conflicting ideas, multiple explanations and contradictory explanations of phenomena ..." (Beeman *et al.*, 1987).

The major goal of cognitive flexibility theory is to promote multiple representations and to achieve a pluralistic thinking (Spiro *et al.*, 1988; Spiro *et al.*, 1991; Jones and Spiro, 1992; Spiro, 1993).

Semantic networking ideas. Some hypertext researchers and designers believe that hypertext information struc-

tures should reflect the structures of human memory. These ideas are essential for semantic networking and they emphasise that mapping the semantic structure of information onto hypertext and explicitly illustrating that structure in the hypertext interface will result in greater changes of the knowledge structures of the readers (Jonassen, 1990, 1992, 1993).

According to Jonassen (1993), schema theory claims that knowledge is stored in information packets, i.e., schemas, that reflect mental constructs for ideas. Each schema that we construct represents a miniframework. Correspondingly, schemas are organised into a network of interrelated concepts known as a semantic network. The nodes in a semantic network are representations of concepts and the links define the prepositional relationships between them. Semantic networks in hypertext represent schemas as nodes and the relationships between schemas as the hypertext links. The rationale for doing so is that by explicitly mapping the semantic network of an expert onto the hypertext, learners may come more readily to think like an expert. Learning, according to this conceptualisation, is the mapping of subject matter knowledge (usually that possessed by the teacher) onto the learner's knowledge structure:

> "we can hypothesise that hypertext structures may be designed to reflect the semantic structure of a subject matter expert... If node-link-node structure of the hypertext reflects the semantic structure of the expert, will the expert's knowledge structure be more effectively mapped onto the novice browser?" (Jonassen, 1993)

As Jonassen (1993) says, the most direct way to map the expert's semantic structure onto a hypertext is to use the semantic map as a graphical browser, i.e., a map with available chunks in hypertext. Getting lost in a large web of hypertext chunks and links is a common problem among hypertext readers, so graphical browsers are developed to provide a spa-

tial map of the organisation of information. As a result, the user will in effect be navigating through the expert's knowledge structure. The question is to what extent the reader will model the expert's structure in their own knowledge representations. According to Jonassen (1992), it is possible to hypothesise that learners who will interact with hypertext will make navigation decisions; and, consequently, will be more involved with the learning materials than will passive readers of linear text. Unfortunatelly, latest empirical studies showed that students lacked clear purpose for studying with hypertext.

Perspective 3: Psychological point of view. Issues of hypertext usability and effectiveness are central to hypertext research; but despite the increasing popularity of hypertext systems very little is known about the psychological processes that characterise the activity of hypertext users (Rouet, 1992).

Beside the very enthusiastic definitions of hypertext, the following ideas have recently entered the educational world: That hypertext is a term now applied so widely that it is no longer clear that it means anything other than the ability to retrieve information rapidly and relevantly by direct selection (Hammond, 1993), that hypertext is a fragmented text form (Whalley, 1993), that hypertext is an excellent idea for the entertainment industry (Taylor, 1993), that hypertext is still only a technology which supports faster retrieval, is more compact, and allows greater manipulation and so forth (Dillon, 1993; Dillon *et al.*, 1993).

Already in the early 1990s Peter Whalley took a rather sceptical approach to hypertext. According to him, discussion concerning the uses of hypertext has often tended to create more heat than light. Traditionally hypertext has been described as a non-linear text with many attractive features: Hypertext has a feature of a goal-directed information filtering, learners in hypertext systems are guided by their choice,

readers can explore the information freely and in multiple paths instead of being bound to a fixed path or information structure, etc.; but most hypertext enthusiasts simply forgot that hypertext was and still remains to be a fragmented text form. According to Peter Whalley (1993), for some learning situations it might work fine to access hypertext's components rapidly and by direct selection, but the question remains: Is it a good idea to fragment educational materials in order to make them more accessible to "browsing"? There is no doubt that an idea or argument will certainly make up more than a single paragraph; but to reduce the presentation of the text into the paragraph or an arbitrary number of small paragraphs means to make it more difficult to present a coherent view (Whalley, 1993). Hypertext obviously provides an efficient technology in those situations when text is conceived as a database of facts. Correspondingly, the true purpose of what hypertext has been designed for is especially for a rapid access of the information and entertainment, for example, as a nice idea in museums.

As Peter Whalley (1993) says, an important starting point in any consideration of hypermedia application is the recognition that they were not purposefully designed for education. This aspect has recently been brought up by researchers who have a rather sceptical approach to hypertext. Actually, we have to accept that nowadays education is more fun oriented as computers, video, and other media have entered the educational world. Peter Whalley stated already in the early 1990s that

> "the general history of the use of new technologies in education has tended to reflect the search of panaceas rather than a serious attempt to solve problems... An important question has to be answered: Whether hypertext should be regarded as the principle controlling medium, or simply as an additional reference resource for standard demonstrational teaching materials".

Patricia Wright (1993) suggests that hypertext design would benefit from a richer appreciation of the variety of reading strategies that people can adopt. Although information seeking while reading with printed materials has received relatively little attention, the problems of retrieving information have been central to much research on electronic documents (McAleese, 1989; Horney, 1992; Rouet, 1992; Dillon, 1990, 1993; Dillon *et al.*, 1993; Wright, 1993). Indeed, the ease of retrieving information is often thought to be a major advantage of having documents in electronic form rather than on paper. On the contrary Jonassen (1993) concludes that "browsing through a knowledge base does not cause deep enough processing to result in meaningful learning"; that hypertexts are information retrieval technologies; and they are not sufficient by itself to result in meaningful processing of knowledge.

The problem of navigation in hypertext has become a subject of great interest to many researchers; and Dillon *et al.* (1993) give a psychological perspective to it. According to those authors, discussion of navigation is prone to difficulty when researchers and designers misapply arguments and evidence from the physical domain to the semantic. Navigation in physical spaces involves four levels of representation: schemata, landmarks, routes, and surveys; and learning to navigate in hypertext, i.e., in electronic space, may involve similar levels. However, Dillon *et al.* (1993) point out that although the notion of navigation is a useful metaphor the conception of hypertext as a "semantic space" is not realistic:

> "Semantic space is an abstract psycholinguistic concept which cannot be directly observed, only represented by way of alternative instantiations... In order to visualise the semantic space it needs to be given physical representation and in so doing, it becomes at most three-dimensional and physically bounded. In this form it is easy to see how concepts such as navigation appear... " .

As Dillon *et al.* (1993) argue, people do not navigate semantic space but rather its physical representations like printed or electronic texts, which are constrained and rather poor. On the whole, psychology is a fragmented discipline, and psychologists talking about hypertext refer to the psychology of the human engaging in a technology; when a wide range of human activities (like reading, writing, designing, navigating, etc.) are analysed and discussed (see McKnight *et al.*, 1993; Wright, 1993; Dillon, 1992, 1993).

Some concluding lines. It has been mentioned by Gall and Hannnafin (1993) that new technologies such as hypertext often give new and innovative capabilities and potential. Yet, there remains a noticeable avoidance of understanding hypertext design and its effects.

Nowadays some researchers still focus on the structural functions of hypertext in order to describe the organisation of human knowledge (Jonassen, 1993), some emphasise hypertext's malleability with contribution to knowledge construction and different perspectives to be taken (Beeman *et al.*, 1987; Landow *et al.*, 1992; Whalley, 1993; Spiro, 1993), some argue that hypertext is only a different medium for representation of information and there is no need for educators or trainers to throw away established learning principles (Dillon, 1993; Wright, 1993; Jonassen, 1993; Whalley, 1993), some give a philosophical, e.g., a postmodernist, perspective in order to say that "hypertext can provide rich and motivating learner-driven environment that can encourage reflective learning experience; or equally, a plethora of glittering immages related only in superficial ways and by their entertainment value" (Taylor, 1993). These are revolutionary ideas in modern hypertext research.

In addition to these novel thoughts, many hypertext designers still have a very traditional approach, i.e., they mainly use hypertext environment for information representation

without any deeper theoretical justification. According to Dillon *et al.* (1993), "what is really needed are well-organized and well-controlled experiments which examine the best means of supporting navigation through large and complex information space".

Since hypertexts of the 1990s have generally failed to show the significant benefits in reading performance and learning that were predicted by many, fewer researchers are now willing to make the sort of strong statements that the medium's earlier advocates did. Nowadays there are more and more critical announcements of hypertext's philosophy, reported by psychologists (Dillon, 1993; Hammond, 1993) and information scientists (Taylor, 1993). Modern researchers are looking forward to finding the arenas where hypertext is and is not an appropriate learning tool. Although there are no clear definitions of the usability of hypertext for specific learning situations; Taylor (1993) already hypothesises that "cumulative" areas (i.e., the sciences with their fact bases) are seen as appropriate for transfer to electronic form while "noncumulative" (i.e., humanities that are crucially dependent on context) may prove inappropriate.

According to Dillon *et al.* (1993), Jonassen (1993), and Wright (1993), different situations call for different solutions; this means that some categorisation of hypertext representations will involve research in the near future. This is a new so-called diplomatic approach to hypertext that has recently entered the world of learning; and it encourages hypertext researchers to work for positive combinations of hypertext and learning in further empirical investigations.

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Received January 1994

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