# Web–Based Instructional Systems



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## INTRODUCTION

Information and communication technologies have played a fundamental role in teaching and learning for many years. Technologies, such as radio and TV, were used during the 50s and 60s for delivering instructional material in audio and/or video format. More recently, the spread of computer-based educational systems has transformed the processes of teaching and learning (Squires, Conole, & Jacobs, 2000). Potential benefits to learners include richer and more effective learning resources using multimedia and a more flexible pace of learning. In the last few years, the emergence of the Internet and the World Wide Web (WWW) have offered users a new instructional delivery system that connects learners with educational resources and has led to a tremendous growth in Web-based instruction.

Web-based instruction (WBI) can be defined as using the WWW as the medium to deliver course material, manage a course (registrations, supervision, etc.), and communicate with learners. A more elaborate definition is due to Khan (1997), who defines a Web-based instructional system (WIS) as "...a hypermedia-based instructional program which utilises the attributes and resources of the World Wide Web to create a meaningful learning environment where learning is fostered and supported." Relan and Gillani (1997) have also provided an alternative definition that incorporates pedagogical elements by considering WBI as "...the application of a repertoire of cognitively oriented instructional strategies within a constructivist and collaborative learning environment, utilising the attributes and resources of the World Wide Web."

Nowadays, WISs can take various forms depending on the aim they serve:

- Distance-learning (DL) systems' goal is providing remote access to learning resources at a reduced cost. The concept of DL (Rowntree, 1993) is based on: (i) learning alone, or in small groups, at the learner's pace and in their own time and place, and (ii) providing active learning rather than passive with less frequent help from a teacher.
- Web-based systems, such as intelligent tutoring systems (Wenger, 1987), educational hypermedia, games and simulators (Granlund, Berglund, & Eriksson, 2000), aim at improving the learning experience by offering a high level of interactivity and exploratory activities, but require a significant amount of time for development. The inherent interactivity of this approach leads learners to analyse material at a deeper conceptual level than would normally follow from just studying the theory and generates frequently cognitive conflicts that help learners to discover their possible misunderstandings and reconstruct their own cognitive models of the task under consideration.
- Electronic books provide a convenient way to structure learning materials and reach a large market (Eklund & Brusilovsky, 1999).
- Providers of training aim to offer innovative educational services to organisations for workplace training and learning, such as to supplement and support training in advance of live training, update employee skills, develop new skills.

The main difference between WBI and the traditional computer-based instructional programs lies in the way information is presented to the user. The WISs' approach to e-learning does not only provide "active learning," which according to Bates (1991) is the most effective way to learn, but also interactivity, which is a well-known facilitator of the learning experience (Mason & Kaye, 1989). Thus, we have, on the one hand, traditional instructional programs which present educational content in a linear fashion using a static structure, and on the other hand, WISs that exploit the hypermedia capabilities, for example, offering flexibility in the deliv-

ery of instruction through the use of hyperlinks (Federico, 1999). As a consequence, WBI has led to a new model for teaching and learning that focuses on the learner not as passive recipient of knowledge but as an active, self-directed participant in the learning process. Nevertheless, this approach to instruction has also created a series of challenges that users of educational technology, such as teachers, learners, providers of educational content, educational institutions and so forth, have to meet: (i) ensure the improvement of learning experience, as usual technology-driven innovations consume prodigious amounts of time and money to little educational effect; (ii) bring a real and substantial change in education by improving their understanding of learning and teaching with the use of this new technology.

This article presents the main features of Web-based instructional systems, including their advantages and disadvantages. It discusses critical factors that influence the success and effectiveness of WISs. It stresses the importance of pedagogy on WBI and explores the pedagogical dimensions of the interface tools and functionalities of WISs. Lastly, it summarises future trends in Web-based instruction.

## BACKGROUND

The appeal of WISs lies in their ability to actively engage learners in the acquisition and use of information, support multiple different instructional uses (tutoring, exploration, collaboration, etc.), support different learning styles and promote the acquisition of different representations that underlie expert-level reasoning in complex, ill-structured domains (Selker, 1994). Learners select the knowledge they perceive as being most suited to their needs. But, although the act of browsing is a pleasing experience, browsing in an unknown domain is not likely to lead to satisfactory knowledge acquisition at all (Jonassen, Mayes, & McAleese, 1993). Thus, navigational aids, such as a pre-defined hierarchical structure of the subject matter, are necessary especially in large domains. The pre-defined structure of the domain knowledge provides learners (especially novices) with guidance during their study, offering them a sense of safety and a reliable navigation path. In this way, learners are supported in constructing their own individualised model of the knowledge space and are able to follow paths through the subject content produced by designers, or to develop their own routes according to individually-prescribed requirements (Large, 1996).

Another attractive element is the flexibility to access course contents through intranets and the Internet at any time and from different places, which is considered as the main reason many educators have tried to develop distance learning programs on the WWW. This flexibility creates many opportunities for exploration, discovery, exchange/sharing of information and learning according to learners' individual needs. Flexibility, however, comes at a price:

- The complexity of the system may increase (Ellis & Kurniawan, 2000). Users may need more time to search for the information (Ng & Gunstone, 2002), and the dynamism and richness of the content may negatively affect learners' level of comprehension (Power & Roth, 1999).
- Despite the plethora of communication tools, learners sometimes find feedback insufficient, feel isolated or not supported enough, and drop out of the course (Quintana, 1996).
- It is unlikely all learners are equally able to performing their own sequencing, pacing, and navigation. Moreover, the learner is not always going to choose the content to study next in a way that will lead to effective learning (Hammond, 1992; Leuthold, 1999).
- Previous knowledge of the domain content varies for different learners, and indeed knowledge may grow differently through the interaction with the system (Winkels, 1992).
- Learners tend to get lost, especially when the educational content is large and/or when they are novices. This can lead to *disorientation* experienced when users do not know where they are within hypertext documents and how to move towards the desired location, commonly known as *"lost in hyperspace"* (Brusilovsky, 2001).
- Learners may fail to get an overview of how all the information fits together when browsing. In the absence of information that might help them formulate knowledge goals and find relevant information, learners may stumble through the content in a disorganised and instructionally