A CONCEPTUAL FRAMEWORK FOR WEB-BASED LEARNING DESIGN

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ABSTRACT

The purpose of this paper is to provide a coherent framework to present the relationship between individual differences and web-based learning. Two individual difference factors have been identified for investigation within the present paper: Cognitive style and prior knowledge. The importance of individual differences is reviewed and previous work on the effect of individual differences on Web-based learning is examined. Problems associated with Web-based learning are identified and discussed in relation to cognitive style and prior knowledge. Possible solutions to these problems are suggested and presented in the form of a conceptual framework that can be used for developing web-based learning systems.

KEYWORDS

Web-based learning, instructional design, individual differences

1. INTRODUCTION

The vast majority of the early research into web-based learning falls outside the area of instructional design in fields long involved in human-computer interaction. With the rapidly increasing use of the Web in our educational systems, a need for *instructional* design for web-based learning has become a necessity. That is, there is a need for guidelines to design effective web-based learning. A suitable approach to such guidelines would be investigating learners' individual differences to identify their needs and preferences. Adaptive web-based learning programs can be then created to meet such needs and preferences.

Among a variety of individual differences aspects, cognitive style and prior knowledge are considered to be viable factors that may influence the effectiveness of teaching and learning. Thus, the aim of the present paper is to review and evaluate how these individual difference factors might influence learning in Web-based learning environments and provide guidelines for instructional designers of web-based learning systems in the form of a conceptual framework. These factors are discussed in depth in the next sections.

2. COGNITIVE STYLES

Cognitive style is defined as an individual's preferred and habitual approach to organizing and representing information (Riding and Rayner, 1998). Research has identified different types of cognitive style. Among these, field dependence/field independence appears to be the most researched cognitive style within education. Witkin, Moore, Goodenough, & Cox (1977) used the term, field independence, to describe individuals who are individualistic, internally directed and accept ideas through analysis. On the other hand, field dependent individuals prefer working in groups, are externally directed, influenced by salient features and they accept ideas as presented. Owning to their characteristics field independent learners outperform field dependent learners in various web-based learning settings (Nozari, Siamian, 2015; Onyekurum, 2015).

Since Web-based learning systems feature the potential for flexibly displaying information in many different ways, characteristics of field-dependent and field-independent individuals described above seem to have instructional and design implications that might influence the quality of Web-based learning. Thus, instead of asking how Web-based material affects student learning, the question to be asked is how

Web-based learning is used by learners with different cognitive styles? The following subsections discuss this issue within three areas: (a) field dependence and hypermedia structure; (b) field dependence and learning behaviour; and (c) field dependence and learning outcomes.

2.1 Field Dependence and Hypermedia Structure

Research has investigated how learners with diverse cognitive styles cope with different hypermedia structures. Empirical studies (e.g. Graff, 2003; Ipek, 2010; Reed & Oughton, 1997) revealed that:

a) field-independent learners are relatively capable of directing their learning by themselves in hypermedia programs with non-linear presentation.
b) field-dependent learners appear to prefer more structured paths to follow in linear learning programs. That is, they prefer to be externally directed.

2.2 Field Dependence and Learning Behavior

Learning behaviours can be considered as learners' interaction patterns with learning materials, instructors, tutors, and peers. In the context of hypermedia learning systems, Research (e.g Ford & Chen, 2000; Somyurek, Guyer, & Atasoy, 2008) indicated that field-dependent students preferred navigational tools such as global maps, which provided an overall picture of the contents, whereas field-independent students preferred tools such as an index or find options, designed for searching for specific information. In addition, other studies (Palmquist & Kim, 2000; Wang, Hawk, & Tenopir, 2000) showed that field-dependent learners navigate the Web in a more linear mode and they get lost more frequently. However, among individuals with substantial online search experience, their cognitive style did not seem to influence any of the search performance or tool usage. Therefore, it might be argued that cognitive style appears as an important factor in designing navigation tools which should be presented in the user interface for learning and teaching.

2.3 Field Dependence and Learning Outcome

The field dependent/independent cognitive style has been identified as an influential factor in academic achievement in both traditional and hypermedia learning settings. In traditional learning settings, field-independent students frequently perform better than field-dependent students in various subject matters (Jamieson, 1992).

In hypermedia learning settings, although research is still inconclusive, the majority of works available indicate that field-independent students will score significantly better than field-dependent students (Noble, Miller, & Heckman, 2008; Nozari & Siamian, 2015). This outperformance of the field-independent students can be attributed to their ability to impose their own organization of structure on learning materials. However, research showed that when sufficient structure and support are provided in hypermedia learning environments (e.g., menu of contents, back/forward navigation buttons, indexes etc.) field-dependent students may overcome the limitations of imposing effective structure on their learning enabling them to perform as good as their peers. The remaining subsections discuss problems field-dependent learners, may encounter whilst learning in hypermedia systems. These problems are: (a) disorientation, (b) learner control, and (c) cognitive overload.

2.4 Problems Field-Dependent Learners Experience in Web-Based Learning

2.4.1 Disorientation

Disorientation refers to users not knowing their position in hypermedia space (Murray, Piemonte, Khan, Shen, & Condit, 2000). It has been observed that field-dependent learners, as opposed to field-independent learners, are more likely to become disoriented during navigation in hyperspace and non-linear hypermedia systems (Palmquist & Kim, 2000; Wang et al., 2000).

It is possible that the ability of field-independent individuals to take an active approach, apply organization on information and extract relevant cues helps them find their way in non-linear learning

environments. Conversely, field-dependent students tend to adopt an approach where they prefer guidance and attend to the most salient cues regardless of their relevance. Therefore, to learn effectively, field-dependent learners need to be provided with more instructional guidance in Web-based learning, which can direct them to the relevant information and reduce disorientation.

2.4.2 Cognitive Overload

Cognitive overload described as the additional effort and concentration necessary to maintain several tasks or trails at one time (Conklin, 1987). This problem can be caused by a large number of choices and decisions the user has to make in a hypermedia system. For field-dependent learners, freedom of navigation could mean confusion and their attention may be diverted from content and relationships as they attend to navigational decision making, especially when accessing large quantities of information. Cognitive overload could also be a result of the ability of hypermedia to present content material in various textual as well as static and dynamic pictorial representations which might become a burden on learner cognition. Such multiple representations might make specific demands on learners. That is, learners have to process different representations simultaneously to construct a coherent mental representation which, in turn, might cause learnersto experience cognitive overload. No published studies have directly investigated the relationship between cognitive style and cognitive overload in Web-based learning environments. However, a number of researchers (Palmquist & Kim, 2001; Wang et al., 2000) have suggested that field-dependent learners are more likely to experience cognitive overload.

2.4.3 Learner Control

Learner control can be defined as the amount of control a learner can have, in an individualised learning environment on the leaning material (Lin & Hsieh, 2001). With regard to cognitive style, empirical studies have suggested that field-dependent learners tend to perform better in program-controlled instruction and prefer to be externally guided, whereas field-independent learners often tend to do well in independent learning (Chen & Macredie, 2002). It can be argued that field-dependent individuals might gain benefit from hypermedia learning systems when less learner control and more guidance are provided. On the other hand, relatively, field-independent individuals enjoy independent learning in hypermedia systems provided with high levels of learner control.

Solutions offered to help learners, in particular field-dependent learners, overcome the mentioned problems and perform well in hypermedia learning environments are presented in section 4. The next section illustrates and discusses the importance of prior knowledge in hypermedia learning.

3. PRIOR KNOWLEDGE AND WEB-BASD LEARNING

Prior knowledge is considered to be a key factor underlying successful learning. Jonassen and Grabowski (1993, p. 417) defined prior knowledge as “the knowledge, skills, or ability that students bring to the learning process. A number of educators and researchers (e.g., Chen, Fan & Macredie, 2006; Chen & Paul, 2003) have recognised prior knowledge as a potent factor that might help them analyse the way in which learners navigate and perform in a non-linear learning environment. Empirical studies in hypermedia learning settings (e.g., Calisir & Gurel, 2003; Chen, 2015; Song, Kalet, & Plass, 2016; Tabatabai & Shore, 2005) showed that learners with high prior knowledge frequently outperform learners with limited prior knowledge and learners with varying levels of prior knowledge show different navigational behaviour and their performance is often affected by types of content structure.

With regard to navigation, research (e.g., Calisir & Gurel, 2003; Chen, Fan, & Macredie, 2006) shows that students with high prior knowledge of the content do not experience disorientation with hypermedia and seem to experience much less frustration while performing their tasks. On the other hand, students with low prior knowledge often suffer from disorientation, exhibited little awareness of where they had been, or where they could go to find the information that they needed.

Regarding content structure, research suggests that experts and novices differ in their performance depending on content structure in hypermedia learning systems (Calisir & Gurel, 2003). It was found that low prior knowledge students benefited more from a hierarchical and linear structure than from a network linking structure. Whereas, High prior knowledge students were able to function equally well in both conditions. In summary, prior knowledge appears to be a viable factor that predicts the way learners react to hypermedia learning system.

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4. A PROPSED FRAMEWORK FOR WEB-BASED LEARNING DESIGN

Drawn from the preceding analysis of the literature, a conceptual framework is developed, as shown in Figure 1 and 2, and suggests several techniques that can be used to address the problems field-dependent and low prior knowledge learners encounter in web-based learning environments. The conceptual framework illustrates the basic characteristics of individuals with field-independent and field-dependent cognitive style and individuals with high and low levels of prior knowledge and their requirements for Web-based learning systems. The proposed framework can help designers to develop web-based learning systems that address effectively the needs of learners with different types of cognitive style and levels of prior knowledge.

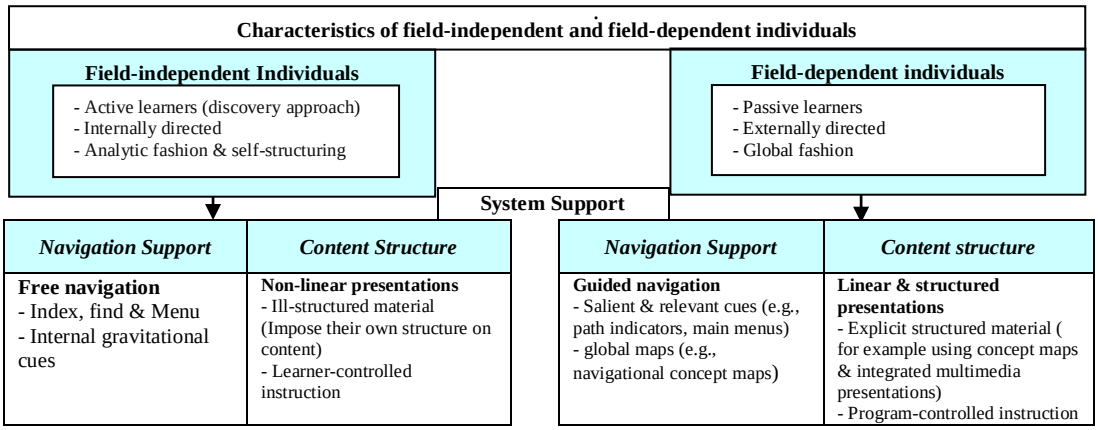

Figure 1. Characteristics of field-independent and dependent-individuals and their implications for Web-based learning

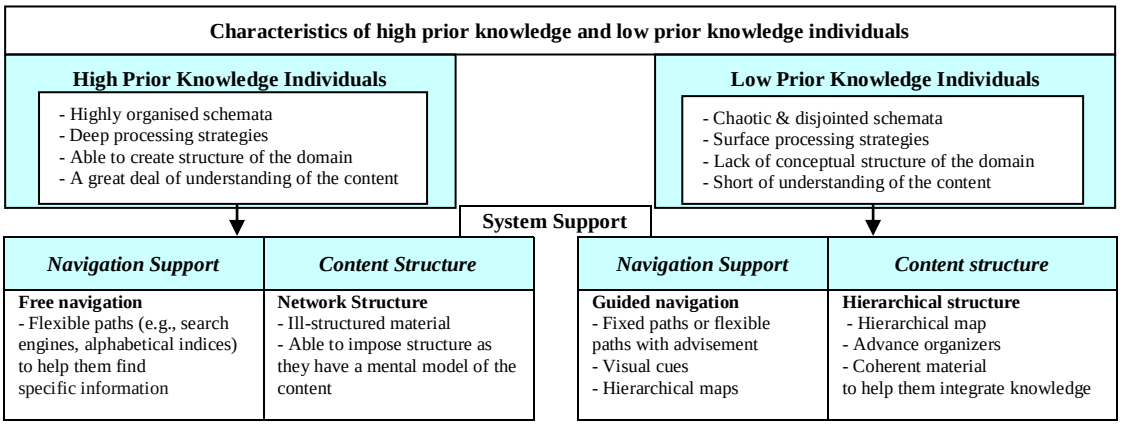

Figure 2. Characteristics of high and low prior knowledge individuals and their implications for Web-based learning

5. CONCLUSION

The manner in which individual differences may interact with web-based material is the major topic of this paper. In particular, it is noted that field-independent individuals do appear to have certain advantages over field-independent peers in many learning situations, especially situations where learners need to impose structure upon a relatively incomplete or disorganised input. However, under certain conditions and with stronger (more organised, more direct) instructional cues field-dependent individuals may learn at similar levels to field-independent individuals.

Prior knowledge seems to operate in a similar manner as cognitive style. Individuals with high levels of prior knowledge appear to be better able to learn and perform in less structured domains, through using their existing knowledge as an effective learning tool. On the other hand, this is not the case with low prior

knowledge learners, whose knowledge cannot assist them in dealing with new information. Such learners cannot rely on their prior knowledge to help them determine the underlying structure of the new learning material. Like field-dependent individuals, individuals with low prior knowledge need more guidance in their learning process. Consequently, the framework proposed in the present paper suggests several techniques that can be used in web-based learning systems to assist both field-dependent students and students with low prior knowledge in their learning experience and improve learning outcomes.

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