Learning with Cognitive Flexibility Hypertexts:

A Background and Review of Current Research

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Abstract

This paper first examines the theoretical underpinnings and established characteristics of Cognitive Flexibility Hypertext (CFH) as a pedagogical model. After CFH's grounding in Cognitive Flexibility (CFT) is reviewed, the characteristics and implementation methods of CFH are overviewed. Next, the paper explores and discusses four published studies that report findings on CFH's instructional effectiveness. Recommendations for future areas of research are then presented in response to the discussion of the review.

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Well-structured and relatively simple content can often be supported by traditionally linear methods of instruction, including lectures, textbooks, and videos. In addition, these approaches tend to be decontextualized and attempt to simplify instruction in order to make complex information more understandable to learners possessing little previous knowledge of the content (Jonassen, 2010). However, these methods of instruction have increasingly been considered ineffective as content becomes more complex and ill-structured, or interpretable in multiple ways (Spiro & Jehng, 1990; Jonassen, 2010). Cognitive Flexibility Hypertext (CFH), an approach for implementing Cognitive Flexibility Theory (CFT), aims to overcome these limitations of traditional approaches to achieve advanced knowledge acquisition in ill-structured domains (Spiro et al., 1988).

This paper first examines the theoretical underpinnings and established characteristics of CFH, and then explores and discusses four published studies that report findings on the instructional effectiveness of CFH as a pedagogical model. Recommendations for future areas of research are then presented in response to the discussion of the review.

Theoretical Groundings

Spiro et al. express concerns with the oversimplification of complex information that can occur in traditionally linear forms of instruction, and suggest that this oversimplification is associated with the development of learner misconceptions (1988). In response to these concerns, they outline CFT as a theoretical framework better suited to support advanced knowledge acquisition in ill-structured domains with its emphasis on the use of multiple mental and pedagogical representations, the interrelatedness and interconnection of ideas, the promotion of

schema assembly (in contrast to the retrieval of prepackaged schemas), and the criticality of cases as alternative perspectives (Spiro et al., 1988; Jonassen, 2010).

Rather than abstract information from complex problems, CFT calls for learning environments to purposefully reflect the complexity of real-world problems, asserting that learners must be presented ideas in the context of authentic situations in order to gain full understanding (Jonassen et al., 1997; Jonassen, 2010). This is specifically accomplished through its emphasis on case-based instruction. In order to provide an accurate depiction of the content domain, instruction should be based on multiple cases or examples rather than only one (Jonassen et al., 1997). Important to note is the fact that the intent of these provided perspectives is not to encourage learners to take the position of any perspective in particular. Through the process of reconciling multiple perspectives from cases, learners must construct their own interpretation of knowledge (Jonassen et al., 1997; Jonassen, 2010).

In addition, CFT attempts to address the shortcomings of limitations imposed by the linearity of traditional approaches. Asserting that understanding of such complex information cannot be obtained with simply one "traversal" of the content, Spiro borrowed Wittgenstein's illustration of "criss-crossing the landscape" of knowledge in order to master complex content (Spiro et al., 1988; Jonassen, 2010).

Characteristics and Implementation

The expansion of random access computer technologies paved the way for new methods of nonlinear and multidimensional learning (Spiro & Jehng, 1990). As a pedagogical model, CFH aims to accomplish the goals articulated by CFT specifically through the use of hypertext environments. Hypertext serves as an excellent medium for information access, as it grants users high levels of control over content access and organization, in contrast to traditional text which

confines readers to the author's pre-determined content structure. This ability fully supports the concept of individuality in learner knowledge structure and information access, interaction, and interrelation preference (Spiro & Jehng, 1990; Jonassen, 2010).

More specifically, ideas and concepts are linked by the CFH's provision of perspectives and themes which tie into presented cases (Godshalk, Harvey, & Moller, 2004; Jonassen 2010). Themes serve as an organizing framework for the cases and ideas, and perspectives provide multiple viewpoints on presented situations with which to provide the learner information (Godshalk, Harvey, & Moller, 2004). Also of importance to note is that while CFH may aim to increase knowledge and awareness of a learner, successful learning via hypertext depends on the learner having some sort of pre-existing knowledge with which to logically assimilate with what they find during the "criss-crossing" process (Jonassen et. al, 1997).

The aforementioned characteristics of CFH lend itself to most effectively support decision-making and policy problems. These kinds of meaningful problems, or *dilemmas*, can provide learners with rich information from various cases, perspectives, and themes with which to build their own interpretations and solutions (Jonassen, 2010).

Literature Review

Jacobson and Spiro (1995) conducted a study in an effort to explore the effectiveness of CFH to promote the acquisition and transfer of complex and ill-structured knowledge. In this study, two hypertext learning environments were used to provide instruction in the social impact of technology. The experimental environment was developed using considerations of CFT, while the control environment was developed to present the same content a more linear and decontextualized fashion. There were 34 participants divided into two groups of equal size, all of whom were freshman and sophomore university students. Out of the 34 participants, 25 were

female and 9 were male. The learning environments were comprised of two parts: a “reading stage” and a “study stage”. During the “reading stage”, both groups of participants were asked to read the same information in a hypertext format. During the “study stage”, the experimental group’s environment utilized the CFT principles of knowledge assembly and interrelationships by allowing nonlinear linking of minicase text sections with the intent of demonstrating different interrelationships that may not have been observed during the reading stage. Conversely, the control group’s environment presented a drill-based exercise on facts and thematic concepts covered in the “reading stage”. The study’s findings supported the hypothesis in that the control group performed more strongly on measures of memory of factual knowledge, while the experimental group demonstrated higher levels of knowledge transfer.

Similarly, Balcytiene also conducted a study (1999) with the goal of exploring the effectiveness of hypertexts utilizing the principles of CFT for complex and ill-structured domains; specifically, classification of art, which Balcytiene describes as a suitable domain due to its nonuniformity of explanation, nonlinearity of explanation, context dependency, irregularity, and lack of defining features. She additionally points out that such an understanding requires the interrelation of information from other domains, such as history and geography. Participants of this study consisted of 38 Finnish university students with an average age of 24.6 who were studying either English or Computer Science. The participants were randomly assigned to a text group or a hypertext group, with 23 students ultimately being assigned to the text group and 15 students being assigned to the hypertext group. Next, all participants were given a pre-test questionnaire to measure their existing knowledge of the content. The text group was presented a 15-page text explaining the nature of Gothic Art, which included pictures of Gothic, Renaissance, and Baroque styles (although no text explanation was provided about any

of the non-Gothic styles). The content in the hypertext was extremely similar, although the content text was divided into 19 smaller standalone paragraphs. These paragraphs were presented with an advanced organizer in such a way that students could explore the content in the order they preferred. Finally, learners were given a post-test questionnaire and stimulated recall interview.

The quantitative results of her study suggested that learners who had less knowledge of a topic benefitted more from the hypertext environment than learners with more knowledge of the topic. Qualitatively, her findings suggested that learners displayed one of three hypertext reading patterns: “systematic reading”, “systematic versus explorative reading”, and “exploration due to individual preferences”. Additionally, based on these patterns, learners could be classified into one of two groups: “self-regulated” learners who display a stronger capability of using metacognitive skills and a smaller sense of text anxiety, and “cue dependent” learners who display a lesser capability of using metacognitive skills and a greater sense of test anxiety (Balcytiene, 1999). Her findings also suggest that “self-regulated” learners benefit the most from a hypertext environment.

Lima, Koehler, and Spiro (2004) aimed to evaluate the effectiveness of Pantheon, a Web-based hypertext environment designed to diagnose complex business cases. Additionally, the researchers compared the effectiveness of Pantheon to the Harvard case study approach, widely heralded as best practice. The Pantheon environment presents learning in several phases. In the first phase, learners work on their own investigative approach within a problem situation. Within the main menu, four core environments that encompass diagnosis are presented: the board room, the research room, the perceptions report, and the final diagnosis. Heavily contrasted with the

traditional and linear case study approach, learners must continually make decisions within Pantheon as to what information will be accessed and which activity must be performed.

Participants of the study included 29 students from a private Brazilian business university, including 19 women and 10 men with an average age of 23.6. The methods for evaluation included focus group interviews, observation, and questionnaires. As predicted, the study findings indicate that participants prefer Pantheon due to its significantly increased interactivity, reflectivity, and authenticity.

Building from previous explorations on the effectiveness of CFH as a model, Godshalk, Harvey, and Moller (2004) sought to examine design considerations that could have an effect on learner outcome; specifically, the potential impact of learning task and attitude change towards the content. For a CFH exploring the topic of sexual harassment, it was hypothesized that the task assignment of policy-maker would foster more positive change in attitude on the subject matter when compared to learners who engaged in the task assignment of juror. Participants of this study included 55 students, with an average age of 33, enrolled in one of four sections of a graduate management course. Two sections of the course were face-to-face, while the other two were delivered entirely online. The hypertext environment was used in the same way across all sections, and participants were randomly assigned the task of either policy-maker or juror. Participants began the study by completing a preinstructional attitude assessment towards sexual harassment. They were then given brief instruction on how to navigate the hypertext, and then allowed to explore the content with the hypertext at their own pace and order preference. A written assignment accompanied the exploration of content, requiring students to develop a policy (for the policy-maker task assignment) or verdict (for the juror task assignment). Before

completing the activity, students submitted their written verdicts or policy decisions to the instructor.

The study's findings supported the hypothesis, with participants who assumed the role of juror displaying lesser positive gains in attitude change than those who assumed the role of policy-maker. This was rationalized by the necessity of the policy-maker role to explore multiple options and opinions, in contrast to the role of juror which forced participants to make a judgment. Godshalk, Harvey, and Moller assert that this could mean topics steeped in controversy and also possible strong emotions may require tasks be designed to allow learners to be understanding of the ill-structuredness of the subject (2004).

Discussion

A review of all four of these studies highlights several common elements, specifically in their themes and limitations.

Common Themes

Each of these four studies touched on several core themes.

Successful reflection of CFT principles. Rather than simply presenting a definition of CFH before outlining research methods, all of these studies explicitly attributed CFT as the theoretical support for their design.

Effectiveness of CFH as a model. These studies found CFH to be an overall effective means of presenting complex information to learners as outlined by the defined characteristics of CFH. This allowed for the focus of the research to shift more towards specific areas of CFH effectiveness. For example, Jacobson and Spiro's (1995) findings suggesting that CFH environment promote transfer more heavily, while traditional environments may sometimes have the advantage on memory development and Balcytiene's (1999) findings that "self-regulated"

learners and learners possessing a lower level of existing knowledge of the content would benefit more from a CFH environment than "not self-regulated" learners and learners with high levels of previous knowledge

Limitations of These Studies

Despite the general support of researchers' predictions by study results, several limitations were acknowledged with the works. The most overarching limitations were the participant composition, as a convenience sampling of university students was the primary method of participant attainment.

Limited number of participants. These studies examined a very small number of participants, with 55 being the highest. Godshalk, Harvey, and Moller (2004) readily volunteer this limitation and attribute it to the fact that face-to-face course sections were examined in their study.

Limited participant diversity. These studies also featured limited participant diversity. Godshalk, Harvey, and Moller (2004) point out that as their participants were largely white and male, a more diverse pool of participants would be needed to be generalizable across various ethnic groups and genders. While two of the studies took place in international universities, the participants within each study possessed little demographic variance from one another.

Additionally important to note is that the participants from all four studies were students. A wider range of participant occupations could serve to be valuable to future waves of research.

Conclusions and Future Study

The support of these studies' hypotheses by the research results have provided a foundation from which future researchers can carry further. As Balcytiene (1999) points out, there is a strong need to explore the effects of hypertext environments on the knowledge

construction of the individual learner. Godshalk, Harvey, and Moller (2004) concur by predicting that the increased use of CFH as the mechanism for exploring ill-structured domains could prompt future studies to find ways to improve CFH learning environment designs, thus providing learners with stronger methods to learn from complex and ill-structured content.

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