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ABSTRACT

This study was conducted to determine whether or not collaborative hypertext affects learning outcomes in the learning of basic concepts in informatics. The researchers organized two university courses about the basics in informatics using collaborative hypertext and two courses without collaborative hypertext. Learning was analyzed, and this paper presents results utilizing the tests of structural knowledge emphasizing learning as a whole. The study found that collaborative hypertext does not improve cognitive learning outcomes in this context. This reflects the need for traditional uncomputerized learning methods at the start of learning informatics or the need to concentrate on improving the truthfulness of a collaborative hypertext-based learning environment. However, the structural knowledge was learned better than single concepts in the groups using collaborative hypertext. Thus, it is concluded that collaborative hypertext supports learning as a whole compared with learning single facts. Topics discussed include: the nature of learning basic concepts, hypercomposition and collaborative hypertext, the study design, and results. One figure presents a simplified concept map concerning information systems development. (Author/DLS)

Learning of Basic Concepts in Informatics Using Collaborative Hypertext: Does Collaborative Hypertext Support Learning as a Whole?

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Abstract: Hypertext appears to be a powerful cognitive tool supporting knowledge construction. A study was conducted to determine whether or not collaborative hypertext affects learning outcomes in the learning of basic concepts in informatics. We organized two courses about the basics in informatics using collaborative hypertext and two courses without collaborative hypertext. We analyzed learning and in this paper we present results utilizing the tests of structural knowledge emphasizing learning as a whole. The study found that collaborative hypertext does not improve cognitive learning outcomes in our context. This reflects the need for traditional uncomputerized learning methods at the start of learning informatics or the need to concentrate on improving the truthfulness of a collaborative hypertext-based learning environment. The result confirms our previous results. However, the structural knowledge has been learned better than single concepts in the groups using collaborative hypertext. Thus, collaborative hypertext supports learning as a whole compared with learning single facts.

1. Introduction

Computational hardware and software have found their way into schools during the last decade. However, the use of these has suffered from a lack of educational perspective. [Hawkins 1993] stresses that computational technology has been brought into schools in the wrong manner. It has been made into a part of traditional teaching emphasizing relatively passive absorption of information.

The same kind of problems have affected computer supported collaborative learning systems. [Wan & Johnson 1994] argue that current systems focus on improving shared access to information, people and media. They emphasize that meaningful learning is often forgotten in regard to collaborative use of computers in education [Webb 1982].

One way to overcome these problems is to consider computers as cognitive tools, in other words, tools for knowledge construction. Meaningful learning is not simply information sharing but, more importantly, knowledge construction [Wan & Johnson 1994]. Generally, cognitive tools can facilitate cognitive processing and knowledge construction, hence they support a learning process [Jonassen 1992]. The use of a cognitive tool changes the role of a student into an active learner. However, hypertext and hypermedia have their own problems. They do not typically offer an explicit mechanism to help learners better interpret and assimilate information, the context surrounding its creation and use, or the perspectives on the information of the author or other learners. Simply improving information access without supporting learning leads directly to the problems of "information overload" and "lost-in hyperspace" [Wan & Johnson 1994]. The solution to these problems is understanding hypertext and hypermedia as a cognitive tool [Jonassen 1992].

2. Nature of Learning Basic Concepts

Since this study recognizes hypertext as a knowledge construction tool and learning as a knowledge construction process, we understand learning especially from the perspective of the constructivist view of learning (constructivism). According to it, an individual learns new concepts in relation to his/her prior knowledge [Risku 1996].

We often distinguish declarative and procedural forms of knowledge. Declarative knowledge represents cognizance or awareness of some object, event, or idea [Ryle 1949]. Declarative knowledge of ideas is often characterized as schemas [Rumelhart & Ortony 1977], which are ideational constructs that are defined by attributes that they inherit from other schemas. Procedural knowledge, on the other hand, describes how learners use or apply their declarative knowledge. [Ryle 1949] describes this type of knowledge as knowing how. An intermediate type of knowledge is structural knowledge, which mediates the translation of declarative into procedural knowledge and facilitates the application of procedural knowledge. Structural knowledge is the knowledge of how concepts within a domain (e.g. in informatics) are interrelated [Diekhoff 1983]. It describes how declarative knowledge is interconnected.

There are two kinds of learning concerning the basics in informatics. First, students must learn to understand the field of informatics and its basic concepts and facts. Second, students must learn to use computers and utilize instructions to facilitate the use of computers. These two goals emphasize the learning of both declarative and procedural forms of knowledge. Since both forms of knowledge are important, we argue that the structural form of knowledge is important. Structural knowledge enables learners to form the connections that they need to use scripts or complex schemas [Jonassen 1992].

For the basics in informatics it is typical that the basic concepts form structures and knowledge is in the structural form [Makkonen 1997a]. One way to understand why the basic concepts in informatics fall into the categories of both declarative and structural knowledge is a concept mapping technique [Novak & Gowin 1984] which facilitates a representation of meaningful relationships between concepts (for an example, see [Fig. 1]).

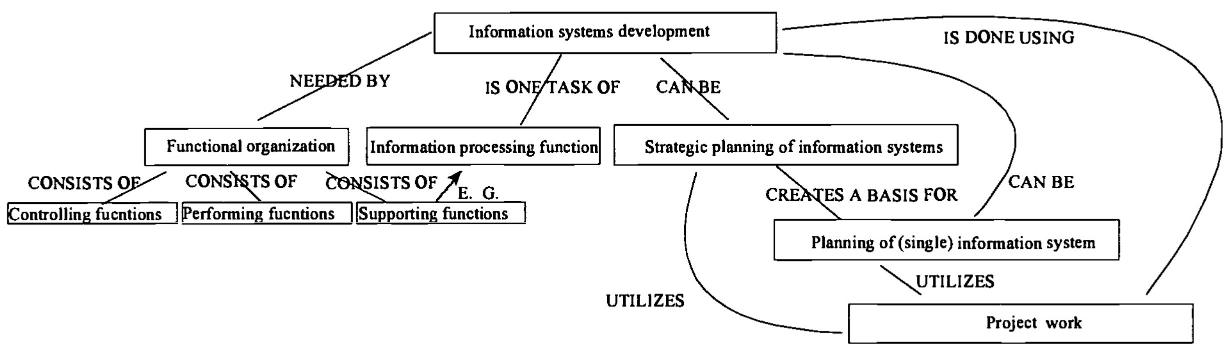

Figure 1. Simplified concept map concerning information systems development.

3. Hypercomposition and collaborative hypertext

Hypertext reflects a human's way of thinking and provides an opportunity to process information and interrelatedness between information cues [Bush 1945] [Jonassen 1993]. It can present a human's schemas concerning one event or idea. Thus, hypertext is useful as a cognitive tool. [Derry 1990] defines cognitive tools as both mental and computational devices that support, guide, and extend the thinking processes of their users. Collaborative hypertext permits hypercomposition and the benefits associated with it.

Hypertext can be called hypercomposition and hypercomposition supports instructional design in several ways [Lehrer 1993]. First, hypermedia-based composition involves the transformation of information into an n-dimension space, in contrast to the two-dimensional space of print. Second, because hypermedia composition involves multiple forms of media, students are confronted with decisions about the representational roles of each of the forms of media. Third, hypercomposition promotes a sense of authorship, if students are engaged in the production of a nontrivial product (a product that others are likely to use). Fourth, hypercomposition encourages the composer to be aware of the multiple voices of his or her composition because there is always more than one path through the hyperdocument. Last, on the social plane, hypertext focuses on the interactions of the authors.

[Rada 1991] has defined collaborative hypertext (grouptext) as "text that people create or access collaboratively". Grouptext systems can help groups create and access text in three phases:

1. The discussion phase occurs as people brainstorm and formulate plans as to how writing should proceed.
2. In the authoring phase, blocks of text are attached to a network of ideas and the network is traversed to generate a document.
3. The analog of reading in the collaborative sense is the making of notes by a group of people on a document. This annotative phase may also lead to a revised document as the annotators incorporate their comments into the original document.

Both hypercomposition and collaborative hypertext can be considered as cognitive tools, because they support knowledge construction. Cognitive tools support the constructivist view of learning because they actively engage learners in the creation of knowledge that reflects their comprehension and conception of information rather than focusing on the presentation of objective knowledge [Jonassen 1992]. This provides different opportunities for learning compared with traditional programmed instruction which is seen as the opposite of cognitive tools [Jonassen 1992] and usually emphasizes the passive role of a student.

We claim that hypercomposition can be used to organize knowledge structures, facilitating a more active role for the student. The basis for this as a learning tool in informatics is understanding concepts and facts which must be learned as structural knowledge. In the learning of informatics hypercomposition does not support learning that only facilitates knowledge construction. Additionally, the process where computers are used for hypercomposition helps students to learn basic concepts in informatics, because students encounter certain concepts in real life situations. To learn meaningfully, individuals must choose to relate new knowledge to relevant concepts and propositions they are already familiar with [Novak & Gowin 1984]. The concept of collaborative hypertext emphasizes knowledge construction. On the another hand this concept stresses social interaction and we suggest that hypercomposition must occur collaboratively, because according to certain research interaction is the factor which has the greatest influence on learning [Harasim 1989] [Webb 1982]. In spite of the promise of hypercomposition and collaborative hypertext they can be more distracting than beneficial, since students must also concentrate on learning a tool itself [Hay et al. 1994].

4. Study Design

4.1 Experiment

We utilized collaborative hypertext as a cognitive tool. Our framework was constructed on the basis of Rada's three phases of the use of collaborative hypertext as well as the idea of hypercomposition.

The themes of our course basic course in informatics are introduction (including the themes Meaning of Automatic Data Processing, Information Society and Problems Utilizing Computers), presentation of data in the PC environment, programs and programming, hardware technology, data communications, information systems development. Two courses organized for university students were based on collaborative hypertext (experimental groups). In order to compare learning based on collaborative hypertext with learning without it two other courses were organized for university students without collaborative hypertext (control groups) using uncomputerized teaching and learning methods. Thus, in the control groups we used contemporary learning methods, i. e., lectures, exercises based on the lectures and revision organized in a linear way as a typical university course based on programmed instruction. However, during the exercises the students were expected to work in collaborative groups as the students did in the experimental groups. All four courses lasted the same amount of time (36 hours in three weeks).

As a hypermedia software we used Toolbook which corresponds HyperCard for Macintosh computers in the Microsoft Windows environment.

4.2 Sample

Forty-six students, 32 females and 14 males, whose mean age was 24 years (range 20-42 years), participated in the experimental groups. 21 students participated in the first experimental group and 25 in the second. Thirty-nine additional students, 30 females and 9 males, whose mean age was 23 years (range 20-39 years), were involved in the control groups. 20 students participated in the first control group and 19 in the second. All students in all groups studied informatics as a minor. All subjects were recruited using the announcements on the notice boards of the university departments and were expected to attend the classes constantly during a selected course.

4.3 Measures and tests

We utilized the tests of structural knowledge to clarify learning outcomes and their quality, because they reflected the quality of a student's knowledge structures. Additionally, the results of these tests complete our previous results. In order to assess structural knowledge acquisition, we utilized two subscales of twenty questions to measure different aspects of structural knowledge: a) semantic relationship, and b) analogies. All of the structural knowledge test questions were developed to focus on relationships between important concepts. Based on these tests we organized both the pre-treatment and the post-treatment contained 20 items in one test. For all tests the items were selected separately.

Each semantic relationship treatment consisted of 20 multiple choice questions that required the students to identify the nature of the relationships between two concepts. These relationships were be paraphrased from the course material.

For example

Operating system...System software

a) is caused by

b) precedes

c) is part of

d) assists

Alternatives were produced based on the list of the most ordinary relationships between pairs of concepts [Jonassen et al. 1993]. According to this list most concepts are related in one of the following ways: Has part/is part of, has kind/is kind of, cause/is caused by, precedes/comes after, describes (defines)/is description (definition) of, assists/is assisted by, has example/is example of, justifies (rationalizes)/is justified (rationalize) by, has characteristic/is characteristic of, has opposite/is opposite of and models/is modeled by.

20 multiple choice questions of each test were given first for the laudatur level students of the information systems. In the questions for the laudatur level students all alternatives from the list of most ordinary relationships were presented. The purpose of this was to produce three different "wrong" alternatives for the tests both in the experimental groups and the control groups. The first alternative or the "right" alternative was produced based on the course material. Three other alternatives were produced based on the results of testing the laudatur level students.

Each analogies test required the students to complete 20 analogies consisting of four concepts from the course material. For example

Bit... Byte

RAM-memory...

a) Central Processing Unit

b) Processor

c) Field

d) Main storage

The alternatives were produced based on the course material. Two from three "wrong" alternatives were closely related concepts of the "right" alternative. One from three "wrong" alternatives was selected randomly from all concepts to learn.

5. Results

In our study we compared collaborative hypertext based learning (the experimental groups) and learning without collaborative hypertext (the control groups). The dependent variables were learning the semantic relationship and learning the anologies. Since the responses of the students agreed with the normal distribution, the T test was approriate for this experiment.

The semantic relationship pre-treatment T test did not show significant difference between the experimental groups and the control groups (p=.161). The mean for the experimental groups was 9.11 and the mean for the control groups was 10.00.

The semantic relationship post-treatment T test did not show significant difference between the experimental groups and the control groups (p=.507). The mean of the experimental groups was 10.93 and the mean of the control groups was 11.05.

The analogy pre-treatment T test did not show significant difference between the experimental groups and the control groups (p=.387). The mean for the experimental groups was 7.96 and the mean for the control groups was 8.33.

The analogy post-treatment T test did not show significant difference between the experimental groups and the control groups (p=.631). The mean of the experimental groups was 10.33 and the mean of the control groups was 11.18.

6. Discussion

Our results show that a basic knowledge of informatics can be learned as easily as utilizing uncomputerized methods without exploiting collaborative hypertext. The finding is consistent with the threats mentioned in [Hypercomposition and collaborative hypertext]. However, the result is promising compared with our previous results in [Makkonen 1997a] where we found that the single facts can be learned more easily using the traditional learning. Thus, collaborative hypertext supports learning as a whole compared with learning single facts.

We lose the benefits mentioned in [Hypercomposition and collaborative hypertext], because much time is used to learn the tool itself. However, we claim that some people can utilize collaborative hypertext as a powerful learning tool. [Mayes 1992] claims concerning the use of cognitive tools generally, that they will always be more effective in the hands of an experienced user. The fact is that the students did not know what our cognitive tool or hypertext was at the beginning of the course. This may impair the results of learning, because students who are not experienced with computers must concentrate more on the skill of using the tool itself than experienced students.

The area of informatics and opportunities to create realistic learning environments may affect the power of hypertext to assist learning. [Kendall et al. 1996] have studied teaching system analysis using a hypertext environment called HyperCase which presents an organization realistically. Their findings showed that those using HyperCase performed as well or better on the examination questions than those using the standard approach. From the perspective of our study, if it had been possible to increase the feeling of reality, the result of this study would have been different. Additionally, our previous findings regarding the engagement to learning in our context support the need of improving truthfulness [Makkonen 1997b]. The study found that the use of collaborative hypertext affects both external and internal motivation equally in learning most themes of the course.

Additionally, the development regarding the world wide web (WWW) may satisfy the need of the truthfulness. The possibility to make links may help learning, because links can be created meaningfully to any document on the WWW which will clarify an area to learn best.

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