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Outcomes of Constructivist Learning Environment: How Learners Apply Visual Design Principles

Oluşturmacı Öğrenme Ortamının Sonuçları: Öğrenciler Görsel Tasarım İlkelerine Nasıl Uygulamaktadırlar?

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Abstract

This study aims to assess how learners apply visual design principles into hypermedia they developed in groups in a constructivist learning environment where they use such hypermedia as a cognitive tool. The study design includes a total of 30 second-year university students who enrolled on an Instructional Technology and Material Preparation course at Middle East Technical University, and which lasted 14 weeks. The data were collected using a Visual Design Principles Evaluation Checklist. The results of the study indicate that the majority of the students applied visual design principles effectively on these hypermedia-based instructional material.

Key Words: Visual design principles, hypermedia, constructivism.

Öz

Bu çalışma, öğrencilerin çoklu ortamın bilişsel araç olarak kullanıldığı oluşturmacı bir öğrenme ortamında, takımlar halinde geliştirdikleri çoklu öğrenme ortamına görsel tasarım ilkelerini nasıl uyguladıklarını değerlendirmek amacıyla yapılmıştır. Örneklemi Orta Doğu Teknik Üniversitesi'nde verilen Öğretim Teknolojileri ve Materyal Hazırlama dersini alan 30 ikinci sınıf öğrencisi oluşturmuştur. Çalışma 14 hafta sürmüştür. Veriler Görsel Tasarım İlkeleri Değerlendirme Listesi aracılığı ile toplanmıştır. Sonuçlar, takımların çoğunluğunun, oluşturmacı bir öğrenme ortamında dönem projesi olarak geliştirdikleri çoklu öğrenme ortamına, görsel tasarım ilkelerinin büyük bir bölümünü etkili bir şekilde uyguladıklarını ortaya koymuştur.

Anahtar Sözcükler: Görsel tasarım ilkeleri, çoklu öğrenme ortamı, oluşturmacı öğrenme.

Introduction

The significance of hypermedia for learning and its motivational effect is stressed in many studies. Flexibility of information organization in hypermedia makes it a powerful tool for effective learning. According to Jonassen and Grabinger (1990), learning is reorganization of knowledge structures. These mental structures are arranged in networks of interrelated concepts known as semantic networks. These networks describe what a learner knows, and provide the foundations for learning new ideas to expand the learner's semantic networks.

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Since it is possible to present information in multiple formats in hypermedia, it promotes the use of more than one information-processing channel, enlarges learners' semantic networks and increases learning. Even though hypermedia presents information in multiple formats and increases learning, according to Jonassen (1996a, 1996b), the main problem related to using hypermedia to facilitate learning is how learners will integrate the information they acquire from the hypermedia into their own knowledge structures. How learners process new information to reorganize, apply, refine and synthesize is an essential issue to be considered. Jonassen (1996a, 1996b) proposed a solution to this problem. In order to have learners integrate the information into their own knowledge structure and construct their own knowledge, hypermedia could be used not as a source of knowledge to learn from but rather as a cognitive tool to construct knowledge and learn with. Hypermedia development places students in the author's seat so that they may construct their own understanding, rather than interpreting the teachers' understanding of the subject. As a cognitive tool application, the learner may create their own hypermedia that reflects their own perspectives of understanding of the subject matter.

Today we use technology for learning in two main ways: Learning from technology, and learning with technology. Traditionally technologies have been used to deliver information and have taken the role of teacher in carrying instructional content to students. In this way information to be passed on to students is stored in the technology and learners perceive and practise with the stored information according to their own learning pace. Computer technologies as cognitive tools represent a significant departure from the traditional conceptions of technologies. In traditional understanding, technologies are used as conveyors of information and in this way students learn from technology. As a cogntive tool, however, technology is used as a partner in learning process. Jonassen (2000) pointed out that students learn with technology when technology supports knowledge construction, exploration, learning by doing, learning by conversing, and learning by reflecting. In using technology as a partner in the learning process, as Turner and Handler (1997) indicate, learners use technology as authors, designers and creators. They conduct research on the topic, identify relevant information, select supporting visuals, design the layout of text and graphics, and determine how the information should be linked. In cognitive tools, information and intelligence is not encoded in educational communications, which are designed to efficiently transmit that knowledge to the learners. With cognitive tools, learners functions as designers using the technology as tools for analyzing, accessing, interpreting and organizing their personal knowledge (Jonassen, 1998b). Jonassen, Carr and Yueh (1998) imply that when computers are used by learners to represent what they know, this procedure necessarily engages them in critical thinking about the content they are studying. Cognitive tools require students to think about what they know in different and meaningful ways. But using technology as a cognitive tool and learning with technology requires a constructivist learning context.

Jonassen, Mayes and McAlessi (1993) mention three main learning processes which they name introductory, advanced and expert learning phases. When learners have a limited amount of transferable prior knowledge introductory learning occurs. In this process learners just begin to construct their mental structure. At an advanced learning phase, to be able to solve more domain specific and complicated problems, learners acquire more advanced knowledge. Experts have more internally consistent and more richly interconnected schemata. In considering the context in which constructivist learning should take place Jonassen et al. (1993) state that constructivist learning environments are most effective in the advanced knowledge acquisition stage of learning. Since each phase of knowledge acquisition entails different types of learning, each also suggests different approaches to learning. The authors state that the initial knowledge acquisition phase is better served through classical instructional design while constructivist learning environments are generally more viable approaches for the second, advanced knowledge acquisition phase. Advanced knowledge acquisition can be fostered at secondary and university education levels to help learners acquire more knowledge. It is better to consider the context before recommending any specific methodology, especially constructivist approaches (Jonassen et al., 1993).

According to the constructivist approach to learning, when real world or relevant context for learning information is lacking , the information is less meaningful. Problem-based, case-based or project-based learning contexts are the ones that are effective in helping learners acquire the knowledge and skills necessary to be effective problem solvers. So, learning should be facilitated and scaffolded in a contextually-based environment that is more meaningful for the learners. Collaborative knowledge construction environments provide an opportunity to all members of a class or learning group to contribute to the interpretation of the information. It is important for advanced knowledge acquisition that learners realize that there exist multiple interpretations for every event or object. Collaborative environments enable learners to identify and reconcile those multiple perspectives in order to solve problems (Jonassen et al., 1993).

Jonassen (1998a) indicates that a constructivist learning environment focuses on a problem, a question, or a project. The environment is surrounded by a variety of interpretative and intellectual support systems, and the learner solves the problem or completes the project in the learning environment. Cognitive tools fulfill a number of intellectual functions in helping learners interact within constructivist learning environments. They may help learners better represent the problem or task they are performing, represent what they know or what they are learning.

There are many research studies which investigated hypermedia's contribution to learning. However how learners construct their own knowledge by creating hypermedia in the knowledge base to be learned has rarely been studied. New research is needed to answer the question of how learners reorganize, apply, refine and synthesize new information by using hypermedia as a cognitive tool. Therefore, the purpose of this study is to find out how learners apply visual design principles to be learned as the course content to hypermedia they develop in a constructivist learning environment where they implement hypermedia as a cognitive tool. The specific research question is "does developing hypermedia as a cognitive tool help learners apply visual design principles to hypermedia they develop." In the context of this study, learners assumed the role of authors of hypermedia. Hypermedia could be used effectively for advanced knowledge acquisition in a constructivist learning context. In this study hypermedia is taken as a cognitive tool that help learners construct their own advanced knowledge in relation to visual design principles in an instructional material preparation course.

Method

Participants

The study design included a total of 30 second year Computer Education and Instructional Technology students who enrolled on a 14 week Instructional Technology and Material Preparation Course in the Fall of 2001 at Middle East Technical University in Ankara, Turkey, for two hours a week. The students had basic knowledge of hypermedia development. In the group high, average and low achievers in terms of their GPAs, and males and females were represented.

Procedures

Before the study started, the students were requested to form project groups of two to five students. There were eight groups in the study. Then students were informed of the procedures of the course and that the course was going to proceed in a constructivist context. Throughout the semester, the students in groups had to develop hypermedia as instructional material, and they should cover most of the course content in that material. Visual design principles were one of the subjects that learners had to include in their hypermedia learning environment. The instructor did not present the course content to the students didactically, but promoted a constructivist learning context in which she facilitated, coached, scaffolded, articulated and guided. The students wrote weekly journals about the course content to form the content of the hypermedia they developed, and received feedback from the instructor on their journals. They participated in group discussions and activities held in the class. While developing their hypermedia learning environment template, each group presented their template in class and received feedback from the instructor and other students in the class. By the end of the semester, the students had finished their hypermedia learning environments.

Data Collection and Analysis

The data were collected using a Visual Design Principles Evaluation Checklist (App. 1) to assess each group's project. The Visual Design Principles Evaluation Checklist was based on the general visual design principles of Heinich et al. (1999) and Web-design principles of Hall (1998). The checklist consisted of items on general design principles such as *arrangement* (covering the areas of proximity, directionals, figure-ground contrast, consistency), *verbal elements* (covering the areas of lettering styles, number of lettering styles, color of lettering, size of lettering, spacing between letters, spacing between lines), *pattern* (covering the areas of alignment, shape, balance, style, color scheme, color appeal), and *Web-design principles* (covering the areas of symmetry-simplicity, consistency, minimizing download time, pre organizing, flexibility, minimizing scrolling and no dead ends). Each group's hypermedia project was evaluated through a scale where 1=low, 2=average, and 3=good for each visual design principle in the checklist.

The data gathered from the checklist were analyzed and interpreted based on the overall performance of the groups on overall design principles, general design principles, web-based design principles and categories of general design principles.

Results

The results gathered from the checklist indicated that most of the groups applied the majority of visual design principles (arrangement, verbal elements, pattern, and Web-design principles) into the hypermedia learning environment they developed as a term project. As presented in Table 1, the majority of the groups applied visual design principles to the hypermedia learning environment they developed. Of the eight groups, one group applied all the visual design principles (M=3), one group applied them below average (M=1.56) and the remaining six groups applied visual design principles above average (range from M=2.26 to M=2.93). The results showed that using hypermedia as a cognitive tool in a constructivist learning context helped learners learn and apply visual design principles into the hypermedia learning material they developed.

As the findings in Table 2 reveal, the majority of the groups applied general visual design principles (arrangement, verbal elements, and pattern) into the hypermedia learning environment they developed as a cognitive tool. Of the eight groups, one group applied all the visual design principles (M=3), one applied below average (M=1.63) and remaining six groups applied general visual design principles above average (range from M=2.56 to M=2.94). It can be stated that using hypermedia as a cognitive tool supported in constructivist learning settings helped learners apply general visual design principles to the hypermedia learning material they developed.

Table 1.
Overall Performance of Groups on Visual Design Principles

	Mean
Group 1	3.00
Group 2	2.78
Group 3	2.59
Group 4	2.67
Group 5	1.56
Group 6	2.26
Group 7	2.93
Group 8	2.93

Note: In this table and the following ones, mean scores are based on a three point evaluation scale where 1= low, 2= average, 3= good.

Table 2.
Performance of Groups on Applying General Visual Design Principles

	Mean
Group 1	3.00
Group 2	2.75
Group 3	2.69
Group 4	2.69
Group 5	1.63
Group 6	2.56
Group 7	2.88
Group 8	2.94

The results gathered on Web-design principles are presented in Table 3. The majority of the groups applied Web design principles (symmetry-simplicity, consistency, minimizing download time, pre organizing, flexibility, minimizing scrolling and no dead ends) into the hypermedia learning material they developed as a cognitive tool. Of the eight groups, two groups applied all Web design principles well (M=3), two groups performed below average (M=1.45 and M=1.82) and the remaining four groups above average (ranging from M=2.45 to M=2.91). It can be concluded that using hypermedia as a cognitive tool in a constructivist context helped learners apply Web design principles to hypermedia they develop as instructional material.

Table 3.
Performance of Groups on Applying Web Design Principles

	Mean
Group 1	3.00
Group 2	2.82
Group 3	2.45
Group 4	2.64
Group 5	1.45
Group 6	1.82
Group 7	3.00
Group 8	2.91

Table 4.
Performance of Groups on Applying Categories of Visual Design Principles

	Arrangement	Verbal Element	Pattern
Group 1	3.00	3.00	3.00
Group 2	2.50	2.83	2.83
Group 3	2.75	2.83	2.50
Group 4	2.75	3.00	2.33
Group 5	1.50	2.33	1.00
Group 6	2.75	2.83	2.17
Group 7	2.50	3.00	3.00
Group 8	3.00	3.00	2.83

Table 4 shows the performance of each group in the visual design categories of *arrangement* (proximity, directionals, figure-ground contrast and consistency), *verbal elements* (lettering styles, number of lettering styles, color of lettering, size of lettering, spacing between letters, spacing between lines), and *pattern* (alignment, shape, balance, style, color scheme, color appeal). In Group 1, Group 7 and Group 8 performance was good. The performance of Group 2, Group 3, Group 4 and Group 6 was above average, and the performance of Group 5 was below average in the majority of the three design categories.

Conclusion

To summarize the design principles applied by the teams, it is clear that the majority of the groups applied visual design principles effectively to the hypermedia-based instructional material they developed as a term project in a constructivist learning environment. A comprehensive analysis of eight projects revealed that using hypermedia as a cognitive tool helped learners apply and represent their knowledge of visual design principles in an effective way. Jonassen (1998b) stated that students learn and retain the most from "mindful" engagement. Some of our best thinking results when students try to represent what they know. Hypermedia as a cognitive tool requires students to think mindfully in order to use the application to represent what they know. Cognitive tools actively engage learners in the creation of knowledge that reflects their comprehension and conception of the information rather than focusing on the presentation of objective knowledge. Analysis of learners' projects showed that using hypermedia as a cognitive tool helped learners comprehend and apply visual design principles and attain the course objectives.

Construction of hypermedia as instructional material provided learners with a constructivist learning context and at the end of the semester they had a product as a result of their application of what they learned. But we cannot conclude that all groups applied visual design principles equally well. One of the project groups performed below average in terms of applying visual design principles into their hypermedia learning material. In this course students were not expected to learn visual design principles only by developing hypermedia learning environment, but also in a situated learning environment that required writing reflective journals and examining the feedback given to their journals by the instructor as a group, participating class discussions and doing instructional activities conducted in the classroom on the subject. When Group 5's performance and level of participation in the activities were examined, it was understood that the group members had not participated in the majority of the class activities, discussions and journal writing. This shows that developing hypermedia in a subject area as a means of learning the subject may not be enough in itself, but should be supported by additional learning activities, and sufficient motivation to assume responsibility in the student centered learning process.

The comments made by the students about the procedures of the course throughout the semester support this conclusion. Students indicated that it was a good practice to have them participate in the instructional procedures actively. Cases or instructional activities that support their study in the subject area were valuable. They stated that they would benefit more if more instructional activities were conducted in the classroom. Providing a rich learning environment that supports the learner designers appears to be very important in regard to advanced knowledge acquisition.

Kafai, Ching and Marshall (1997) concluded in their study that students need more support in their collaborative work if the design situation is to be an effective learning context for each individual team member. Having learners design and develop hypermedia learning environments to learn a subject area is not an easy instructional activity and may not result in sufficient learning by itself. To benefit more from using hypermedia as a cognitive tool, students should be guided throughout the process and supported by additional instructional activities to keep them on track and focus their attention on key aspects of the subject area. It is a care-taking procedure both for the instructor to be a facilitator and for the student to be a designer. However, technology is an effective tool, and learning through technology provides a worthwhile learning experience.

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Appendix: Visual Design Principles Evaluation Checklist

	Low	Average	Good
Arrangement			
Proximity			
Directionals			
Figure-Ground Contrast			
Consistency			
Verbal Elements			
Lettering styles			
Number of lettering styles			
Color of lettering			
Size of lettering			
Spacing between letters			
Spacing between lines			
Pattern			
Alignment			
Shape			
Balance			
Style			
Color scheme			
Color appeal			
Web-Design			
Symmetry-simplicity			
Consistency			
Minimize download time			
Pre organizer			
Flexibility			
Minimize scrolling			
No dead ends			