



Who Benefits from WWW-presentations in the Basics of Informatics?

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ABSTRACT

This paper describes the use of WWW-based guided tours as a complementary addition to conventional lectures in the basics of informatics. Learning can be promoted in the spirit of constructivism, situated action, and cognitive flexibility when organizing a WWW-coursework. We analyze the benefit of an optional coursework including the use of guided tours and the use of search engines and directories on the WWW. This paper presents who benefits and who does not benefit from our optional coursework. The analysis is based on the background information and prior computer experience of the students as well as pre- and post tests. The study found that our WWW-based coursework suits best for females and all students except the students of economics. The students who are not familiar with computers and the Internet benefit more from WWW-based learning. Age and the number of years studied at a university do not affect the effectiveness of the WWW-coursework. The results show that our WWW-coursework suits for basic course level students in informatics regardless of age. However, in the continuing courses of informatics the coursework is probably less effective.

INTRODUCTION

For example, Isaacs [8] and Rosenthal [13] have reported problems in regard to traditional lecture-based teaching including ineffectiveness, an increase in passivity, and isolation in students. In the context of technology revisions have been suggested to improve lecturing as a teaching method by activating students in different conventional ways [9]. From this perspective lecturing is not without potential if the previously mentioned problems can be corrected, but other learning methods must also be considered.

Hypertext and the WWW (the World Wide Web) enable learning as knowledge construction allowing information and concepts to be represented as a learner adopts them. This helps meaningful learning. One alternative to conventional lectures is a presentation on the WWW. This presentation can be supported by coursework emphasizing learning as knowledge construction.

Hypertext and hypermedia have some problems. They do not typically offer an explicit mechanism to help learners better interpret and assimilate information, the context surrounding their creation and use, or the perspectives on the information of the author or other learners [17]. Improving information access without supporting learning leads directly to the problems of "information overload" and being "lost-in-hyperspace". Thus, students need some degree of guidance. Additionally, the form and structure of hypermedia presentations must be discussed. This is more important in the era of the WWW.

The WWW provides both the possibility to organize information in a strict form and opportunities for free "surfing" with its advantages and disadvantages. To realize the benefits of the WWW we suggest a solution of three layers: (a) the support of guided tours as a slideshow on the WWW, (b) the support of appropriate links, and (c) the support of search engines and directories. This approach may provide a basis for a successful WWW-coursework.

This paper introduces our WWW-based coursework as a way to apply the WWW in the learning of basic concepts in informatics. Additionally, it presents who benefits from the WWW-coursework in education. This study defines the concept "benefit" related to the quality of learning concepts. The analysis is based on the psychology of knowledge and a pre-questionnaire.

LEARNING CONCEPTS

This study understands learning as knowledge construction in the spirit of constructivist theory (constructivism). An individual learns new concepts in relation to his/her prior knowledge.

This psychological perspective of our research can be divided into the perspective of cognitive psychology and the perspective of developmental psychology. They both emphasize learning as knowledge construction.

Perspective of Cognitive Psychology

Cognitive psychology distinguishes declarative and procedural forms of knowledge. Declarative knowledge represents cognizance or awareness of some object, event, or idea [14]. Procedural knowledge describes how learners use or apply their declarative knowledge. Structural knowledge mediates the translation of declarative into procedural knowledge and facilitates the application of procedural knowledge. It is the knowledge of how concepts within a domain (e.g. in informatics) are interrelated [7]. We comprehend learning as a knowledge construction process of both declarative and structural knowledge where a learner's goal is to approach an expert's knowledge structure or the requirements of a course.

Perspective of Developmental Psychology

In developmental psychology conceptual knowledge can be approached using Collis's [6] modification of Piaget's stages of development. This approach creates a basis for evaluating learning outcomes emphasizing the quality of learning concerning a single concept and interrelatedness between the concepts.

Based on Piaget's stages of development a SOLO (Structure of the Observed Learning Outcome) taxonomy divides learning outcomes into five classes. These classes reflect the quality of a learning outcome. Learning outcomes (i.e., definitions of con-

cepts) can be classified as follows using the SOLO taxonomy [3]:

1. Prestructural.
2. Unistructural.
3. Multistructural.
4. Relational.
5. Extended Abstract.

A student's response can be classified according to the capacity, relating operation, and consistency and closure of his/her response. Pre-structural responses are based on irrelevant or inappropriate data (level 1). Unistructural responses are based on conclusions on one aspect (level 2). Multistructural responses are based on isolated relevant data (level 3). Relational responses are based on relevant data and an understanding of the interrelations of different data in responses (level 4). Extended abstract responses are based on an understanding of data and interrelations both in the context of a question and in unexpected situations (level 5).

CONSTRUCTIVISM

Widely discussed views associated with (computer-supported) learning include behaviorism and its opposite constructivism. Behaviorism focuses on a student's behavior in relation to teaching, while constructivism is interested in the mental processes, which affect behavior. A traditional lecture is mainly based on the behaviorist approach while coursework and projects are constructivist learning.

Constructivism asserts that learners construct knowledge [4]. Learning is comprehended as the development of a learner's mental models (or declarative and structural knowledge). Brandt [4] emphasizes that constructivism is a basis when applying the WWW for learning. While the goal of constructivism is to recognize and help to facilitate a learner's ability to construct knowledge when applied to teaching information retrieval on the Internet, it also provides the teacher with a structure for teaching. By focusing on concepts and connecting them to mental models, teachers can gain both confidence and control over the amount of material they cover in the small blocks of time usually allotted to teaching. Integrated with experiences that learners use to alter and strengthen mental models, the constructivist approach to teaching information retrieval also gives users the structure needed to get the most out of the Internet. However, traditional instruction is needed to support constructivist environment [15].

THE WWW IN LEARNING

The problems inherent in hypermedia such as disorientation, navigation inefficiency and cognitive overload are multiplied on the Internet [4]. These problems can be overcome using the constructivist approach, but it is useful to discuss the use of the WWW from other perspectives. One alternative is trails and guided tours as a way of improving the usefulness of the WWW. Additionally, the concepts of situated action and cognitive flexibility can be discussed from the perspective of the WWW-based education.

One way to organize a WWW-presentation is trails and guided tours. Trails connect a chain of links through information spaces [2]. These can include "recommended" trails through a network. Guided tours restrict users to the trail, prohibiting detours. While trails lower the cognitive overload by recommending the next logical link to take, guided tours reduce the overload further by removing all other choices.

The success of a computer-supported learning environment depends on the context in which that software is used [10]. The

term "situated action" emphasizes the interrelationship between an action and its context of performance [5]. It stresses a person's responsiveness to the environment and focuses on the improvisory nature of human activity [12] and the local management of activity as mediated by relevant environmental cues [1, 16]. The implications for learning are that appropriate actions are generated from recognition of opportunities given by the context.

Additionally, Jacobson et al. [9] emphasize the meaning of cognitive flexibility theory affecting hypertext-based learning. This theory proposes that complex knowledge may be better learned for flexible application in new contexts by employing case-based learning environments.

Based on the above we must discuss what the right amount of behaviorist teaching is and we must analyze what the right way to use the WWW is. Active learning must be promoted and the pitfalls of the WWW must be avoided. Additionally, support for students is needed in learning based on the WWW.

COURSE AND ITS WWW-COURSEWORK

Experiment

At our university an introductory course in informatics lasts 10 weeks including lectures (8 hours), compulsory exercises in basic skills with personal computers and the Internet (18 hours), and a final examination.

In 1998 our approach to using the WWW for education was to combine

- trails and guided tours,
- both behaviorist teaching and constructivist learning,
- situated action, and
- cognitive flexibility theory.

In the WWW-based learning the basic point is situated action. The constructivist approach is the commonly accepted principle for learning. Since the structural form of knowledge is typical for the basic concepts of informatics [11], it is natural to approach the course from the perspective of constructivism. However, in our context, students may need guidance at the beginning and traditional educational methods based on behaviorism are partly appropriate.

The students were introduced to our approach. The pre-questionnaire, which was administered at the beginning of the course, supported our approach.

- Based on the above-mentioned the lectures consisted of
- printed lecture notes,
 - conventional lectures,
 - lecture notes on the WWW including links to supporting sites, and
 - optional WWW-coursework concerning lecture notes on the WWW.

As mentioned earlier conventional lectures and printed lecture notes are needed as a behaviorist part of the course, but WWW-material provides an opportunity for the constructivist approach. The lecture notes were organized in the form of a guided tour as a slideshow using Microsoft Powerpoint 97 and its Internet assistant providing support for a student who is at the beginning of learning in informatics. Each slide may include a set of links to interesting WWW sites and the slideshow can also be comprehended as a trail. Our slides included links concerning the critical concepts to the link pages, which were evaluated as supporting learning. The form of a lecture is flexible and it can be seen as a trail or a guided tour depending on the situation. Based on our approach a student can also support his or her learning using search engines and directories. This allows different views and brings a real constructivist way to learning.

To realize the benefit of our WWW-approach we organized a coursework in which students were expected to enter their findings in their diaries including their opinion about (a) the form of presentation, (b) the links provided by the teacher, and (c) the links found by the students themselves using search engines and directories (i. e. Altavista and Yahoo). The students were expected to give examples of what they had learned during the coursework. To promote the students' participation in the optional coursework, the students got credits by completing the coursework for the examination. The students had six and a half weeks for the coursework before the examination. The work was conducted as an individual task or in groups of two or three students.

Sample

One hundred and three minor students, 77 females and 26 males, whose mean age was 23 years (range 19-42 years), entered the course and completed both pre- and post-treatments. They all participated in the computer exercises (18 hours) and all the students had the same exercises. Participating in the lectures (8 hours) and the coursework was optional.

Forty-six of the students, 38 females and 8 males, whose mean age was 22 years (range 19-40 years), participated in the optional coursework. 17 of them completed the coursework individually, 23 in groups of two students and 6 in groups of three students. The students spent 13 hours (range 5-30 hours) on the coursework on average. They attended 6.5 hours of lectures and spent 43 hours on the course on average. We call this group the WWW group in this paper.

Fifty-seven students, 39 females and 18 males, whose mean age was 23 years (range 19-42 years) did not complete the optional coursework. These students attended 4.9 hours of lectures and spent 31 hours on the course on average. We call this group the non-WWW group in this paper.

Collecting data

We utilized a SOLO taxonomy-based measure to analyze learning [11]. Both the pre-treatment and the post-treatment contained 15 separately selected items. These items were chosen randomly from 88 critical concepts to learn of the whole learning area. Those concepts were selected by the group of the teachers (n=12) of informatics in our university. In each test respondents produced 15 definitions of randomly selected concepts. In the responses the students were expected to define concepts using certain sentences clarifying the basic properties of each concept and connections between these properties. The responses of the students were ranked from 1 to 5 based on the quality of learning. The basis for the rankings was the contemporary definitions of these concepts that were included in our material.

To study who benefits and who does not from the WWW-coursework, data were collected by administering a pre-questionnaire to the students including general information like gender, age, number of years studied at the university, and faculty. Additionally, we gathered information about the experience with computers and the Internet. The respondents ranked their skills or knowledge or the amount of use/training on a 5-point Likert scale (where 1=very poor/little and 5=very good/much).

Results

Since the data based on the responses of the students disagreed with the normal distribution, the Mann-Whitney test was appropriate to compare means. We found based on the SOLO

taxonomy that the WWW-coursework improves learning outcomes significantly in our context [11]. Cronbach's alpha to show the reliability was 0.72 in the pre-treatment and 0.77 in the post-treatment. In this paper we report the results based on those previous results [11] and the general background and the prior experiences with computers.

(a) Results Based on Background

Analyzing data based on the gender showed that females benefit significantly more from the WWW-coursework. Table 1 shows the details of analysis.

Table 1: Analyzing responses based on gender

	Mean of WWW Group	Mean of Non-WWW Group	p
Females (n)	38	39	
Beginning of Course	1.56	1.59	.313
End of Course	2.65	2.45	<.001
Males (n)	8	18	
Beginning of Course	1.75	1.84	.222
End of Course	2.48	2.48	.834

To clarify if the age affects learning the Pearson correlation coefficients were calculated for both the WWW-group and the non-WWW-group. The correlation was not significant in either case. Thus, the age does not affect the benefit of the coursework significantly.

To clarify if the number of years studied at the university affects learning the Pearson correlation coefficients were calculated for both the WWW-group and non-WWW group. The correlation was not significant in both cases. Thus, the number of years studied at the university does not affect the benefit of the coursework significantly.

Analyzing data based on the faculty showed that both the students of social sciences and humanities benefit from the WWW-coursework. Regarding the students of economics no significant difference has been found. Table 2 shows the details of analysis.

Table 2: Analyzing responses based on faculty

Faculty	Mean of WWW Group	Mean of Non-WWW Group	P
Social Sciences (n)	9	15	
Beginning of Course	1.54	1.60	.540
End of Course	2.64	2.30	<.001
Humanities (n)	28	28	
Beginning of Course	1.55	1.65	.018
End of Course	2.62	2.48	.030
Economics (n)	9	10	
Beginning of Course	1.76	1.67	.324
End of Course	2.61	2.54	.478
Other (n)	-	4	
Beginning of Course	-	2.05	-
End of Course	-	2.70	-

(b) Results Based on Prior Computer Experience

Analyzing data based on the prior training (before the course) of computers shows that the WWW-coursework is beneficial for students who have had less prior training. First, we compared the students who have had prior training to the students who have not had it. Second, to clarify if the amount of prior training affects learning the Pearson correlation coefficients were calculated for both the WWW-group and the non-WWW-group. The correlation was not significant in either case. Table 3 shows the details of

comparing means.

Table 3: Analyzing responses based on prior computer training

Prior Training	Mean of WWW Group	Mean of Non-WWW Group	p
Yes (n)	33	42	
Beginning of Course	1.65	1.65	.935
End of Course	2.67	2.45	<.001
No (n)	13	15	
Beginning of Course	1.44	1.71	<.001
End of Course	2.49	2.49	.868

To clarify if the amount of prior work experience with computers affects learning the Pearson correlation coefficients were calculated. Based on the analysis the WWW-coursework is beneficial for the students who have less work experience with computers. Table 4 shows the details of analysis.

Table 4: Analyzing responses based on prior work experience with computers

	Correlation Coefficient of WWW Group	p (WWW Group)	Correlation Coefficient of Non-WWW Group	p (Non-WWW Group)
Beginning of Course	.144	.002	.141	<.001
End of Course	-.079	.084	.008	.824

To clarify if the prior general experience with personal computers affect learning the Pearson correlation coefficients were calculated. For these analyses the students were expected to evaluate their experience based on a 5-point Likert scale. We analyzed if prior experience with personal computers affects learning. The positive correlation was significant at the level 0.01 at the beginning in both groups. At the end the positive correlation was significant at the level 0.05 in the WWW group and at the level 0.01 in the non-WWW group. The result shows that the students who are not very experienced with personal computers can benefit slightly more from the WWW-coursework. Table 5 shows the details of analysis.

Table 5: Analyzing responses based on prior experience with personal computers

	Correlation Coefficient of WWW Group	p (WWW Group)	Correlation Coefficient of Non-WWW Group	p (Non-WWW Group)
Beginning of Course	.224	<.001	.194	<.001
End of Course	.083	.029	.147	<.001

We analyzed if prior experience with the Internet affects learning. The positive correlation was significant at the level 0.01 at the beginning in both groups. At the end the positive correlation was not significant in the WWW group and the positive correlation was significant at the level 0.01 in the non-WWW group. The result shows that the students who are not very experienced with the Internet can benefit more from the WWW-coursework. Table 6 shows the details of analysis.

Table 6: Analyzing responses based on prior use of Internet

	Correlation Coefficient of WWW Group	p (WWW Group)	Correlation Coefficient of Non-WWW Group	p (Non-WWW Group)
Beginning of Course	.190	<.001	.141	<.001
End of Course	.006	.879	.122	<.001

We analyzed if prior knowledge of basic concepts of information technology affects learning. The positive correlation was significant at the level 0.01 at the beginning in both groups. At the end the positive correlation was significant at the level 0.05 in the WWW group and at the level 0.01 in the non-WWW group. The result shows that the students who are not very experienced with basic concepts of information technology can benefit slightly more from the WWW-coursework. Table 7 shows the details of analysis.

Table 7: Analyzing responses based on knowledge of basic concepts of information technology

	Correlation Coefficient of WWW Group	p (WWW Group)	Correlation Coefficient of Non-WWW Group	p (Non-WWW Group)
Beginning of Course	.235	<.001	.236	<.001
End of Course	.091	.017	.158	<.001

Finally, we analyzed data based on owning a PC and the Internet connection. The analysis showed that the WWW-coursework is beneficial especially for the students who do not own them. Table 8 shows the details of analysis.

Table 8: Analyzing responses based on possessing own PC and Internet connection

Owning a PC (or Another Microcomputer)	Mean of WWW Group	Mean of Non-WWW Group	p
Yes (n)	25	34	
Beginning of Course	1.63	1.77	.002
End of Course	2.58	2.54	.462
No (n)	21	23	
Beginning of Course	1.55	1.51	.655
End of Course	2.68	2.34	<.001
Owning Internet Connection			
Yes (n)	9	13	
Beginning of Course	1.76	1.96	.009
End of Course	2.44	2.66	.051
No (n)	37	44	
Beginning of Course	1.56	1.58	.304
End of Course	2.67	2.40	<.001

DISCUSSION

Our results show who wins and loses by participating in the WWW-coursework. Regarding the general background the WWW-coursework suits best for females and all faculties except the students of economics. The age and the years studied in the university are not important factors concerning WWW-based learning. Regarding the previous computer-related background of the students it appears that the students who are not familiar with the computers and the Internet benefit more from the WWW-coursework. The result reflects the importance of computer facilities in the campus area since the students who do not own a PC or the Internet connection benefited most from the WWW-coursework. On the other hand, these students were in the worst situation related to

the knowledge of basic concepts at the beginning of the course. Generally, the results provide more evidence that the WWW-coursework is one effective way for WWW-based education. Outside informatics we can recommend it to any subject, in which knowledge consists of concepts forming knowledge structures. In the continuing courses of informatics the WWW-coursework may be less powerful because in our study the students who were familiar with computers benefit less from the WWW-coursework.

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