Are knowledge networks suitable
for supporting learning at university courses?

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Abstract

Knowledge networks can be used to support alternative learning methods at university courses. A method is proposed for activating the students in the learning processes at university courses. The method combines: 1) Active learning where students are training each other, 2) eLearning from intranet based knowledge networks, and 3) Problem Based Learning. The method has been tested and evaluated at two university courses with a total of 127 students and the results show that: 1) Students show a high appreciation of the method, 2) Teachers show a positive interest in the method, and 3) The method makes learning more efficient and is recommended to be used at university courses in general where the theoretical scope of the course can be represented in a knowledge network.

Keywords: knowledge network, active learning, eLearning, seminar, knowledge management

1. INTRODUCTION

In knowledge networks, members can share information and reuse each other's knowledge. A possible application of knowledge networks is to use them for educational purposes. We participated in the development, testing and evaluation of two courses that use knowledge networks as a tool for learning and examination. The courses were held at the Department of Computer and Systems Sciences at Stockholm University.

The aim of the presented work was to find out whether the type of knowledge network used on these courses is suitable for use at university courses in general, but specifically at courses with an IS/IT perspective. We were motivated by a vision of replacing rigid, traditional university courses with a new dynamic use of technology in combination with active learning. In the survey that this paper is based on, the students' and lecturers' attitudes towards using knowledge networks were investigated by allowing them to participate in various experiments, where their performance and their attitudes were measured.

We introduce a type of knowledge network that combines technology and face-to-face communication in a way that motivates people to contribute knowledge to the network. It comprises:

- A technical part of the knowledge network which consists of a web site with descriptions of knowledge from a specific theoretical domain. Each page of the web site:
  - conforms to a predefined standard syntax in order to facilitate browsing in the network.
  - was created by a student as an assignment during a university course.
- Seminars where students teach each other the theories that correspond to the knowledge that is described in the network.

In the following sections we will describe how the knowledge network can be used to support learning. We will start by discussing learning methods and then continue by describing the proposed method. Finally we will present empirical evaluations of the method.

2. ALTERNATIVE PERSPECTIVES ON LEARNING

This method is based on several different components such as active learning, technical networks that are IT-based, and interaction through seminars .In this section we briefly outline some perspectives on learning.

Formal vs. Informal Learning

According to Norman (1993) the traditional form of learning in a classroom is not to be recommended, as it is hard to focus on a single subject for fifty minutes and therefore Norman proposes other models for learning. He identifies the differences between formal learning (school situation) and informal learning (for example through multimedia games). One difference between these two types of learning is that in informal learning the learning is self-paced, whereas in formal learning the activities are fixed, forced-paced. Another difference is that in informal learning the person can choose subject, time and place, whereas in the school situation these parameters are appointed beforehand. Yet another difference described by Norman is that in informal learning, the goal is well motivated from the learner's point of view whereas this is not always the case in formal learning

Active Learning

Bonwell and Eison (1991) describe active learning as a form of learning characterized by the fact that the students do more than just listen; they read, write and discuss. Furthermore they are involved in "higher-order thinking tasks as analysis, synthesis and evaluation" (Bonwell & Eison 1991, p. iii). In active learning the emphasis lies not in transmitting information but in developing the students' skills.

In the proposed method the design of the seminar is based on the theories of active learning. The seminar is designed to activate all the participants to such an extent that, at any time in the seminar, each student will either be active in teaching a fellow student or in being taught. However, there are differences between the proposed method and active learning. The most significant distinction is that this method has a necessary element of technology, since a prerequisite is a web site with students' knowledge contributions. The web site is thoroughly structured in order to facilitate storing and retrieving complex knowledge descriptions. In this way the web site functions as a knowledge base.

Problem Based Learning: Problem based learning (PBL) is a form of active learning. It represents a challenge to the orthodox view on education and learning. Charlin, Mann et al in Nuldén (1999) acknowledge three core principles for problem based learning: "/…/(1) the problem acts as a stimulus for learning; (2) it is an educational approach, not an isolated instructional technique; and (3) it is a student centered approach/…/" (Charlin, Mann et al in Nuldén 1999, p.12).

The base for learning in problem based learning is the student's own questions, experiences and problem definitions. Problem based learning is usually claimed to be a method to help students develop a number of different skills, for example adaptation and participation in changes, solving problems, decision-making in new situations, critical and creative arguing, acting with empathy and appreciating someone else's point of view (Nuldén 1999). According to Walldal (1995) the skills obtained from problem based learning are to learn how to learn, how to work in groups and how to solve problems.

The proposed knowledge network implements PBL in two ways:
1. Each description of knowledge on the web contains a problem to be solved, an analogy that will give a hint as to how the problem can be solved and the final solution to the problem.
2. In the seminars the students are forced to solve the same problems as were presented on the web.

3. A DESCRIPTION OF THE PROPOSED LEARNING METHOD

The method used at these courses has a technical and a social component. The technical component consists of a web site that can be reached from the course's homepage on the Internet. Linked together on this site are a great number of homepages with students' assignments. This is referred to as the knowledge network. It is vital, for two reasons, that the contributions to the web site follow a given template. The first reason is that the readability increases when all contributions to the network look the same, and the second is that if the material is to be reused, which is central within Knowledge Management, it must be possible to transfer the knowledge to a form that facilitates searching. The social component of the proposed method consists of a seminar where the students participating in the course transfer knowledge to each other. This knowledge transfer has its basis in the knowledge network, which the students can browse and study each other's assignments. These two components together form the learning method evaluated in the survey that this paper is based on.

How this Method can be used

The method has been used at courses within the areas of social sciences and computer science at Stockholm University. The courses evaluated concern the construction of knowledge based expert system and construction of knowledge bases. During these courses the evaluated method was used together with traditional lectures and group assignments.

The Knowledge Network: The theoretical scope of the course is divided into half as many subjects as there are students on the course, and each student is assigned one of these specific subjects. Each subject is assigned to two students however the students have to solve the task individually. Each student should construct a problem related to the subject, an analogy or some hints as to how it can be solved and finally a solution to the problem. This should then be presented on a web site together with a question where the reader can check his/her understanding of the subject and a theoretical description of the subject in general. The web sites have to be formatted according to a template given in advance. When all students have completed their contributions they are linked together on a web site to form a knowledge network, which the students can browse. Students then read each other's work on the network and tests themselves by trying to solve the problems related to the theories. To deepen understanding of the different subject areas, the students then coach each other at the personal training seminar described below.

The Personal Training Seminar: To motivate the students to browse through the network and to give them the opportunity to intensify their knowledge, the network should be complemented with a learning seminar. The seminar should take place in an auditorium and the students should be divided into two groups, where one group (one student per subject) act as personal trainers and the other group is to be trained. Each personal trainer represents a knowledge training station and the students that will be trained move between stations until they have visited every station. Whenever a student arrives at a training station the personal trainer presents the problem and the student tries to solve it. If the student cannot solve the problem, the trainer helps by giving a hint via the analogy. If the student still does not know the answer, the personal trainer explains the theory behind the problem. The student is allowed to move on to the next station when the trainer thinks that the student understands the theory. When all the stations are covered everybody changes roles. The trained students become personal trainers and vice versa.

How the Proposed Method was Evaluated

Every student registered on the two evaluated courses (called *78 and *38) participated in the study. Lecturers without experience of using knowledge networks in this context participated in another evaluation of the proposed method. Each of the lecturers had responsibility for at least one course. The participating lecturers are active within different areas and different subjects. The empirical evaluation was carried out at the Department of Computer and Systems Sciences at Stockholm University. This department combines computer science with social sciences and has an even gender distribution. The department is relatively large and since the examined courses do not require programming skills or extensive technical experience they can be compared to other courses at social sciences departments. The empirical study was carried out through questionnaires and interviews; the students' attitudes were ascertained through questionnaires and the lecturers' opinions through interviews.

4. RESULTS

The questionnaires

*Question 1: Would you propose that similar methods for collecting knowledge, like the ones used during the two courses *38/*78, where used to a greater extent in other courses?*

Options	*38	*78	Sum
	%	%	%
No, not at all	9	0	6
Hesitant	13	13	13
It doesn't matter	3	6	4
Yes, maybe	49	56	51
Yes, definitely	26	25	26

In the questionnaires we received positive comments about the value of being able to search for and find useful information independently of the lecturer. The fact that the students taught each other in the seminar was also popular. Many students thought that the material on the knowledge network should be checked to ensure that the author of the contribution had interpreted the theory correctly.

Question 2: Do you think that the knowledge network built by the students, is a sufficient alternative to a book that is mandatory to read?

Opinions	*38	*78	Sum
	%	%	%
Very bad	7	0	4
Bad	21	2	14
Equivalent	13	9	11
Good	28	48	36
Very good	31	41	35

The fact that every student had interpreted his/her part of the material and placed it in context has facilitated the learning according to some students. More positive comments were received when the contributions were

made according to a template than when no template was used, which indicated that standardization through templates is necessary. Once again there was criticism about the absence of checks on the correctness of the material in the knowledge network.

Question 3: What is your opinion about the seminar in which knowledge is transferred from student to student (the personal training seminar)?

Options	*38	*78	Sum
	%	%	%
Very bad	3	0	2
Bad	12	0	7
Neutral	10	2	7
Good	33	49	39
Very good	42	49	45

Many students thought that the interaction was very rewarding and claimed that the discussions about the different subjects led to an increased understanding. Unfortunately some of the students experienced the environment as noisy and messy, which led to difficulties concentrating.

Question 4: Do you think that this learning method (including the knowledge network and the seminar for knowledge transfer) can be used at university courses in general?

Options	*38	*78	Sum
	%	%	%
No, not at all	10	3	8
Hesitant	18	28	21
Doesn't know	10	0	7
Yes, maybe	33	41	35
Yes, absolutely	29	28	29

Among the comments were those expressing that the knowledge was transferred more efficiently with this method than in traditional courses and that alternative learning methods were appreciated. Another frequent viewpoint was that this learning method could be applied only at certain courses. Several students did not think the method would be suitable for courses in programming.

The interviews
Question 1: Would it be possible to divide the theoretical material in your course, so that each student is responsible for one part?
Nearly half (three out of eight) of the interviewed lecturers thought that this was possible. Some claimed that checking the material before it was published on the knowledge network would be necessary. The reason for this is that there is a risk that the student might have misinterpreted his/her part and that this misunderstanding could disseminate among the other students. There were also those who expressed an interest in the method, but did not think it would be feasible on their courses for various reasons. One example of this is if there are a large number of students attending a course, it may become difficult to divide the theoretical material into a sufficient number of pieces. Two of the interviewees did not believe in the method at all.

Question 2: What is your opinion about holding seminars where the students teach each other their part of the theoretical material?
More than half (five out of eight) of the interviewees had a positive attitude towards the seminars. Three lecturers expressed skepticism. The reason for this was partly because the method did not fit the subject, and partly due to factors concerning time and economy.

Question 3: What do you think about having material from the course on a network containing, for example, previous years exercises?
Almost half of the interviewees (three out of eight) claimed, for different reasons, that it would be better not to publish former solutions. The reasons for this were (1) you learn better by doing things yourself, (2) every student has the same task and this task is reused every year and (3) if the subject does not change over time it will be hard to construct new, meaningful tasks. Four of the interviewed lecturers were positive to this kind of reusing knowledge and one respondent gave no clear answer to the question.

Question 4: Would you be interested in participating in a seminar about the use of knowledge networks in education?
Seven out of eight interviewees were interested in participating in this kind of seminar, but four expressed doubt as to whether they would have the time. The eighth respondent expressed interest in receiving the information from the seminar but not participating.

Questions	Positive	Hesitant	Negative
1) Possible to divide material	3	3	2
2) Opinion about personal training	5	3	
3) Opinion about reuse of material	4		3
4) Interested in the method	7	1	

5. ANALYSIS

In order to find out whether it is rewarding to use knowledge networks to a greater extent in academic education, a number of criteria for evaluating the success of the implementation of the network have been outlined. This has been accomplished through interviews and through studies of literature. An analysis

based on these criteria and to what extent the criterion was fulfilled is presented below.

Criterion 1: A positive attitude towards knowledge networks in education

Two prerequisites for Knowledge Management-projects are that the management is dedicated to the project and that the organization has a KM-friendly climate (Liebowitz 2000; Davenport & Prusak 1998). This criterion can, for the evaluation of this method, be divided into two more specific criteria, one regarding the students and one regarding the lecturers: *(1a) The students should be of the opinion that this is an efficient way of learning* and *(1b) The lecturers should not feel that the method results in an extra workload.*

(1a) To draw conclusions on whether the students think that this is an effective way of learning is difficult, as the students' experience of the learning method is subjective rather than objective. When analyzing the answers of the questionnaires we have seen that students in general think that this learning method works well. This is founded on the fact that a predominant part of the answers were positive. (1b) Since the lecturers would have to learn a new method for teaching, they could initially experience an extra workload. In spite of this, the survey has shown that there is an interest for alternative learning methods.

Criterion 2: There should not be unhealthy competition between students

A factor that makes knowledge transfer more difficult, according to Argote (1999), is competition. The fact that the students show a positive attitude towards the knowledge network and the personal training seminar indicates a relatively small occurrence of unhealthy competition. There are no comments, which show reluctance to sharing knowledge, but there are a number of positive comments showing that the students thought the discussions and conversations about the subjects were valuable and that they contributed to a deeper understanding.

Criterion 3: No practical difficulties in implementing the network should exist

According to Högberg and Edvinsson (1998) one of the prerequisites for a knowledge network is a physical environment (IT-system and network), that makes it possible to store and share knowledge in an efficient way. One condition for knowledge transfer, in the form being used during the courses *38 and *78, is that every student can have his/her own homepage where their part of the theoretical material is presented. The condition was satisfied by using a feature of the IT-based conference system used in the department, in which it is possible for a non-experienced student to publish a homepage.

Criterion 4: The students must accept and conform to a standardization

According to Rosenberg (2001) the information submitted to the network should be formatted or written in a certain way, which can be accomplished by using templates. During the first course where the method was used (*38) there were no guiding principles for how the material on the homepages should be structured and this led to comments about difficulties reading the information. When the second course (*78) started the conditions had changed and there were now strict rules on how the information should be presented which led to positive feedback from the students. This shows that the students accept to conform to a standard and also that they believe that the strict formalization facilitates the learning.

Criterion 5: The realization of use of knowledge networks in education should be based on existing research

There must be research within pedagogy, which supports the introduction of an alternative method, such as knowledge networks, in education on an academic level. Examples of this kind of research exist in areas such as active learning and problem based learning, where the student more actively takes part in the learning whilst another pedagogy is used (Walldal 1995).

Criterion 6: In the long run it should be possible to transfer the information in the knowledge network to a database

To be able to transfer the material in the knowledge network to a database the formulation of the material must be regulated and standardized. This can be accomplished through templates defined in advance and by introducing regulations of the content of the web pages. The material published on the network during the courses *38 and *78 differed in this aspect. During *38 the students designed their homepages without templates, but during *78 there was a template which every contribution had to follow. The conclusion that can be drawn from this is that the material from the course *78 can be transferred to a database, but the material from *38 needs a thorough revision before such a transfer is possible.

Criterion 7: There should be more than one channel for knowledge transfer

A success factor for KM, according to Davenport and Prusak (1998), is that there should be several channels for the transfer of knowledge, and for this reason knowledge repositories ought to be combined with face-to-face meetings. During the courses investigated in this study this combination of channels for knowledge transfer was applied. In our method the knowledge repository is equal to the knowledge network, i.e. the web site with students' homepages, and this channel for

knowledge transfer is supplemented by meetings during the personal training seminar.

Criterion 8: The lecturers responsible for courses need to know how the learning method should be applied and how the knowledge network should be structured
In order for knowledge networks to be efficiently used as a tool for learning, the lecturers responsible for the courses must master the method and be able to create a distinct and easily navigated structure for the content of the knowledge network. As the lecturers interviewed had no experience of knowledge networks in education, this criterion cannot be fully answered. The analysis was instead made from the lecturers' attitudes towards learning more about the method and whether they were open to changing their courses. In the survey several of the interviewed lecturers claimed to be interested in alternative learning methods.

Criterion 9: It should be possible to divide the theoretical material on the courses into areas, so that every student can be responsible for one part and share his/her knowledge with the other students
With the current form it is a prerequisite for the courses using knowledge networks that every student can become an "expert" in an area and then transfer his/her knowledge to the other students through the knowledge network and through face-to-face meetings during a seminar. During the interviews with the lecturers it became apparent that some of them had doubts on whether the material on their courses could be divided into a sufficient number of pieces so as to have a similar structure to the courses *38 and *78. Another factor pointed out by the lecturers was the large amount of students at some of the courses (up to 150-200 people) and therefore they thought the method would be difficult to apply. This assumed difficulty expressed by some lecturers has no empirical foundation but may be a result of lecturers being hesitant to something new that disturbs their routines. It seemed as if they did not understand that one purpose behind the knowledge network was to lessen their workload by allowing the students to take on more responsibility for the processes of collecting theoretical material and for the teaching.

Criterion 10: There ought to be a comprehensive check of the material being published on the network in order to make it trustworthy
The fact that there are no formal checks of the material before it is published on the network can be thought of as a cause for uncertainty. This was also shown in the study, as both students and lecturers expressed concern about the material not being trustworthy, or that a possible misconception might spread among the students. For this reason the material should be checked before it is published on the network. With the form currently used at the courses no such check is made prior to the seminar for knowledge transfer, but one is made afterwards. If the lecturer responsible for the course was to reorganize his/her tasks so that the checking takes place prior to the seminar, the students would probably trust the material to a higher degree, which should result in higher motivation when learning the other students' contributions.

A summary of the results from the analysis

Criteria	Result
1a) Students positive	Yes
1b) Lecturers positive	Partly
2) No unhealthy competition	Yes
3) Easy implementation	Yes
4) Accept standardization	Yes
5) Based on research	Yes
6) Transfer to database	Possible
7) Several knowledge channels	Yes
8) Lecturers master method	Partly
9) Divide theoretical scope	Yes
10) Checking of the material	No

6. CONCLUSIONS

The results of the study show that the method works well at university courses. This indicates that the learning method can be recommended for use to a greater extent. We see, however, some limitations regarding when the method can be used. Both students and lecturers expressed doubts as to whether the method is applicable on all types of courses. They were especially reluctant to courses of a practical nature, i.e. programming courses. This will be investigated in coming studies.

Another conclusion that can be drawn from the results of the survey of students' attitudes is that alternative learning methods like the proposed method are appreciated and asked for. A predominant part of the students has a positive or very positive attitude towards the method used at the tested and evaluated courses.

As the interviewed lecturers, with one exception, had no experience of knowledge networks in education and therefore could have had difficulties understanding the method, it is more difficult to draw conclusions about their attitudes. One conclusion that can be drawn from the results, however, is that most lecturers are interested in the proposed type of learning method.

Have the Objectives of the Evaluation Been Fulfilled?
One of the objectives with the survey described in this paper, was to investigate the students' attitudes towards knowledge networks as a tool for learning in courses on an academic level. The study showed that the students in general have a positive attitude and from the students' viewpoint there are no obstacles, such as unhealthy competition or a reluctance to conform to standardization, to the introduction of this kind of method.

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The second objective was to find out if there was an interest in using this method among lecturers responsible for courses with no experience of knowledge networks in education. In the empirical study it has become apparent that the lecturers were not positive to the method to the same extent as the students, but they expressed an interest in learning more about it.

The last objective was to make an analysis, based on theoretical studies and the empirical evaluation, on whether it is rewarding to use knowledge networks to a greater extent in education on an academic level. Out of the criteria that the analysis was based on, criteria three, five, six, seven and ten deal with different aspects of importance for this objective. These criteria mean for example that there should be no practical difficulties in implementing the knowledge network and that the realization should be based on existing research. Out of these criteria all but one (criterion 10) were fulfilled in the situation investigated. What is needed in order for both students and lecturers to trust the information in the knowledge network is a check of the theoretical material being published on the web sites.

7. DISCUSSION

We believe that one factor that has affected the attitude to knowledge networks is if the respondent has used the method for educational purposes or not. For a person lacking this experience it might have been hard to understand the method through just a short description. Furthermore it is possible that the interviewer has had difficulties explaining such a complex method during the short time the interview lasted. A contributing factor to the lecturers relatively hesitant attitude could also be that they have a heavy workload and therefore might have trouble finding time to change their courses, even though we believe such a change would mean a reduction in workload in the long run. This is founded on several factors such as the reusing of material, the fact that students can find answers to frequently asked questions in a database and the students' ability to use the network to help each other to a greater extent.

In discussions with lecturers and course assistants it was discovered that the proposed method was much more popular than the traditional teaching methods used in previous versions of the courses. Since the proposed method of using knowledge networks for educational purposes is quite recently developed and has not yet been used in many courses, it might be possible to further refine the method by means of the comments received from the students in the survey. By using the learning method on a greater number of courses this would lead to feedback from other groups of students, thereby facilitating the method's further development. There is also a possibility that different lecturers could design variations of the learning method, which could lead to it being widely used within different areas.

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