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Knowledge Management Integrated Web-Based Information Security Course Tutoring System*

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In this study a model and software package called WebCoach, which operates as a learning content management system (LCMS), has been developed. It is a web based tutoring system that uses knowledge management techniques to convert the tacit knowledge of experienced lecturers and experts into explicit knowledge. The instructional contents, quizzes and assessments, glossary of terms for information security course were prepared, compiled and organized by this tutoring system. They can be used and reused as learning objects to support learning. WebCoach fulfils the requirements for e-learning standards. It has been applied at Istanbul Commerce University within the information security course. Course grades and student questionnaires for two groups of undergraduate computer engineering students were analysed in the course of this study. The control group did not have access to WebCoach, while the same course was taught via WebCoach to the experimental group. The teaching methodology of the control group was based on a classical narrative model. It was observed that the students using WebCoach achieved better results compared with the control group students, for example, 86% of the students were satisfied with the WebCoach system.

Keywords: web-based education; knowledge management; learning content management system; learning objects; tacit knowledge codification and organization

INTRODUCTION

IN WEB BASED EDUCATION SYSTEMS (WBES), students study the contents of the course using their course books, together with the assistance of visual multimedia and simulation/ animation items. Classical WBE sites that have been awarded with MERLOTS Classics Prize can be given as examples in this area [1]. In these WBES environments, the experience and knowledge of the experts are not relevant. Tacit knowledge is the knowledge people acquire through their own experiences and it is more valuable than other forms of knowledge. It is proved that capturing, organizing and storing tacit knowledge of experienced educators and making it available to others can be achieved through knowledge management techniques [2–9]. Using this, various studies have shown that targets can be achieved in a shorter time, the level of understanding is increased, the problems are solved efficiently and right decisions are taken in many fields by using KM techniques [10]. In most studies that includes KM as a tool or concept to be used in education, the importance of transferring tacit knowledge as well as explicit knowledge to students for the subject to be taught is emphasized [11, 12]. Apart from other studies, the WebCoach model not only helps codifying tacit knowledge to explicit knowledge, but also serves as a learning object to be used in the construction of other online WebCoach education systems.

WebCoach has an environment similar to Distributed Interactive Learning (DIL). DIL, in brief, is a type of web based education environment based on structured hypertext navigation, rather than just delivering linear learning materials such as Word files and presentation files [13].

In the conducted study, information is either explicit knowledge or codified tacit knowledge accessed as hypertext navigation. In addition to the DIL environment, it supports multimedia formatted documents such as image files, audio files, video files and presentations files.

Moreover, WebCoach is based on a flexible framework that provides the instructors with many opportunities in designing the courses by using shared, reusable learning objects. Learning objects developed by one institution can be shared with another institution, thus they can provide high quality courses to every student. Expert instructors at each institution maintain a repository of learn-

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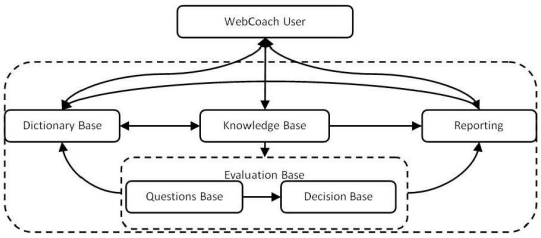

Fig. 1. WebCoach system architecture.

ing objects. This will make the course's structure more flexible and its design less costly.

The information security course covers one of the fields that has been most studied by computer engineers and it is being taught according to traditional education approaches. The content of this course changes frequently due to the advent of new technologies. Information security education is dynamic, consistently updated and mostly based on the intellectual reserves of the experts. It also comprises a great deal of tacit knowledge.

The WebCoach model has been developed to meet the requirements of a system through which the information security course can be given to both students and teachers online.

WEBCOACH MODEL

The developed WebCoach model provides an integrated online environment for administration of both students and teachers, enrolment, course setup, content creation and organization, online communication, online student assessment and monitoring of student performance. It involves a reusable learning object and learning object repository to ease the compilation of the content. Taking into account these features, we can say that the model operates as LCMS. But as an ongoing project that has its own content compiling and forming environment, WebCoach yet cannot support all of the e-learning features. WebCoach has been developed to fulfil scalability, accessibility and reusability, except for the characteristics of interoperability. Figure 1 shows the architecture of WebCoach system.

WebCoach user (knowledge workers)

There are three users in the WebCoach model: students, instructors and a system administrator.

Students accesses WebCoach through the internet with their user ID by following the system, as they make progress and take the required tests, which increase in difficulty and complexity. They may be advised by the system to repeat certain sections based on the results of the tests. If the student fails a test they are provided with a diagnostic report by the system, showing the issues that they have to improve. As a result, the student becomes an independent problem solver.

The instructors prepares the course content using reusable learning objects developed by them or by other experts to provide a high quality course to every student. WebCoach helps them in preparing course content. They check the progress of the students and determine success criteria. Also they are responsible for the dynamic expansion of the course content. When finishing the tutorial part, they prepare the assessment part of the course.

The system administrator is responsible for the registration and coordination of the students and instructors.

Knowledge base

The knowledge base is a database where the knowledge is collected in an electronic environment; it shows how to present explicit and tacit knowledge. The main principle to follow is that the explanatory sentences should be selected from the knowledge base. The selected sentences should also be motivating and encouraging rather than simple ones. Figure 2 shows the way knowledge is organized including the aim, main steps, tasks and risks.

The significant sections of the knowledge base are defined as Aim, Main Steps, Tasks and Risks [14].

- *Aim:* A sentence should be written in a way that involves the targeted level/efficiency. Upon completing the task, students should feel some emotional excitement, motivating them to accomplish more of the following tasks. In this part, the success criteria of the goal that needs to be achieved is also defined.
- *Main steps:* Explain chronologically the phases to be completed so as to achieve related objectives. The exact meaning and the content of the 'main step' is defined in detail to make these sentences more understandable. Where necessary, additional documents can be added to each definition.
- *Tasks:* Tasks for each main step are put separately into the system. Defining the main steps also makes it clear who is responsible for specific task. While setting the tasks, the order of task completion is taken into account. When necessary, additional documents can be added to the task. People who are expected to carry out these tasks are reflected as roles. Giving students the responsibility of a role should ensure cooperative study.
- *Risks:* Possible problems and difficulties while achieving the aim. The expert makes a quick analysis of the risks. In this way, a risk can be foreseen, what kind of precautions can be taken to prevent it and how to take action for an already present risk. Figure 3 shows the organization of tacit knowledge.

Other modules

- *Dictionary Base:* This module helps students to look at technical words, abbreviations and similar expressions. A double click is enough to look at the meaning of an unknown word.

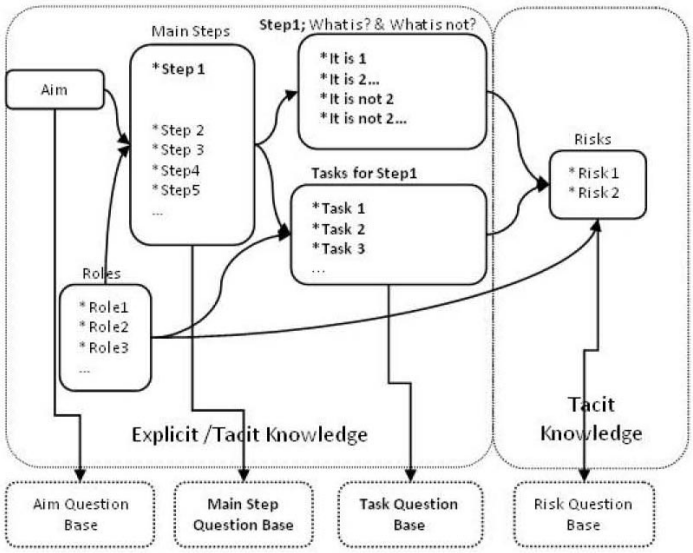

Fig. 2. Organization of the knowledge in knowledge base.

- *Evaluation Base:* It includes a question base and decision base.
- *Report Base:* It reports the test results to the student and instructor and shows the weaknesses and strengths of the students.

DESIGN AND EVALUATION OF THE MODEL

In classic WBES, the content of a subject is given as simple text with multimedia files supported by animations or simulations. However, WebCoach presents the information derived from the codification of tacit knowledge, such as the meaning of the problems that can arise during the education process, how to solve them, the reasons for them, and what should be done to avoid these kinds of difficulties and problems.

In designing the WebCoach software, the flow diagram shown in Appendix 1 is used. The interface shown in Fig. 4 has been prepared for the users of this software.

Two groups of undergraduate computer engineering students participated in the information security course at Istanbul Commerce University. The control group was composed of 79 students enrolled in the course during the spring semester of 2007; they did not have access to WebCoach. The experimental group contained 34 student enrolled in the course during the spring semester of 2008; these were taught the course on the basis of WebCoach. Course grades and student questionnaires of both the control and experimental groups were analysed. At the end of the semester the experimental group students participated in a five-point Likert-type scale questionnaire. Student opinions about WebCoach system are showed in Appendix 2.

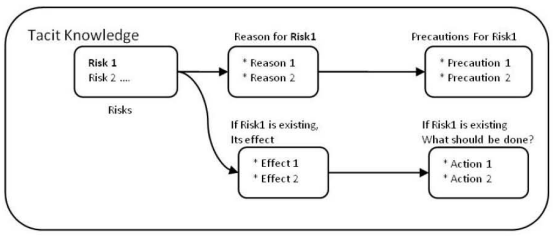

Fig. 3. Organization of tacit knowledge.

Examining the answers of the students, it was observed that WebCoach achieved an 86% positive response. The questionnaire given in Annex 3 was applied to the control group that attained the classical education. Questionnaires were analysed with the help of Statistical Package Social Science (SPSS) software. Its reliability was tested with Cronbach reliability analysis. The results of the reliability test are shown in Table 1.

Here are some explanatory information on the results taken form Appendix 2:

Questions 11, 13 and 15 in the questionnaire given in Appendix 2 show the evaluations of the students related to the guidance given to them on technical subjects, how clear and detailed the subject was and how easy it is to follow the subject by using the WebCoach system. The average of the answers to these three questions was 4.18 out of 5. This shows that students found the guidance of WebCoach adequate and by simply following its guidance, they could achieve their aims.

Questions 6, 11, 4 and 9 evaluated whether or not the students achieved the aims of the information security education on their own using the developed model. The average of the answers to these questions was 4.2 out of 5. Looking at the answers to these questions, it was observed that students believed they could achieve the aims on information security on their own. Students thought that the education offered with this model would lead them to success.

Table 1. Reliability tests

Questionnaires	Cronbach (alpha)	Standardized
Experimental group—34 students	0.9419	0.9452
Control group— 79 students	0.8560	0.8624

How easy it was to use the developed model has been evaluated with the assistance of questions 16, 17 and 18 in the questionnaire. Here the average is 4.48 out of 5, which means that students thought it was easy to use the program.

Narrative method was chosen as the classical education method. Some 79 students from the Department of Computer Engineering, Engineering Faculty of Istanbul Commerce University have received classic education in this way. This method was supported by projection apparatus, an education technology tool.

At the end of this, classic education students were given the questionnaire in Appendix 3 in order to ascertain their opinion. Immediately afterwards, they took a 46-question exam to evaluate their success. The average number of correct answers in the control group was 21.1, and 30.7 for the experimental group. Thus it was proved that the students who received WebCoach-supported education were more successful than those who received the narrative method.

CONCLUSIONS

In this study, information security educational courses were given to two groups of students in which, one group has used WebCoach and one the classic education method. The opinions of the students on these methods were obtained through the use of questionnaires. The compiled results from questionnaires, exams and exercises, concluded that the education received by the students who used WebCoach was more efficient than the classic education.

This system is an educational technology application that incorporates the use of tacit knowledge of different subjects into education. Apart from being an educational instrument for the transfer of information, the WebCoach system is also a system that ensures the transfer of special skills, perception abilities and experience. It is understood that compared with classic education, students are more successful in an education that is supported by the WebCoach system.

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APPENDIX 1

WebCoach flow chart

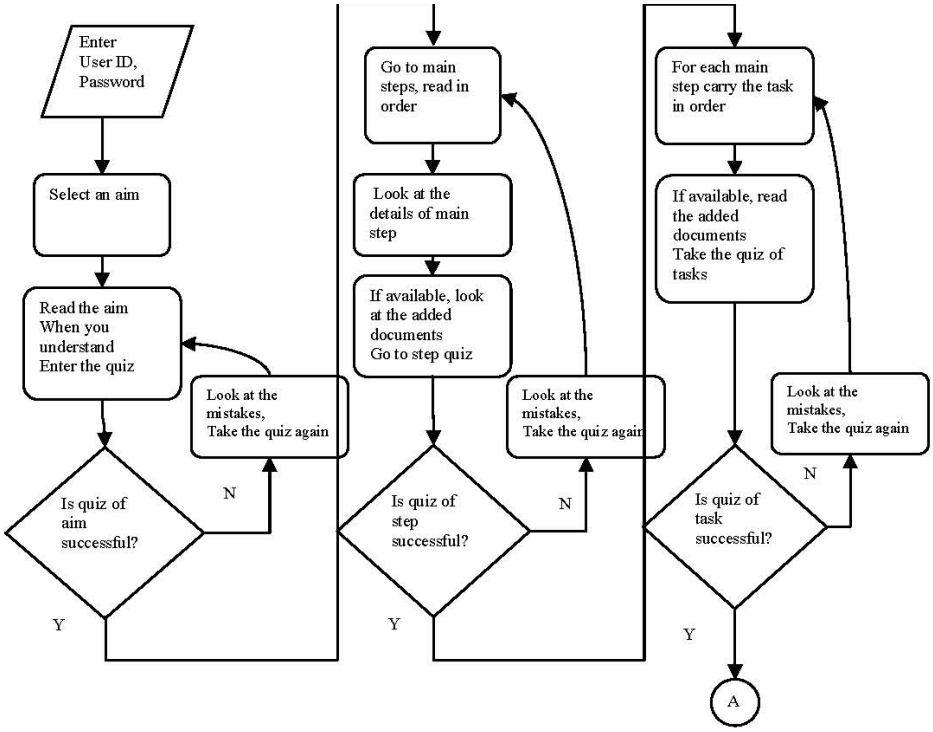

Figure A.1A.

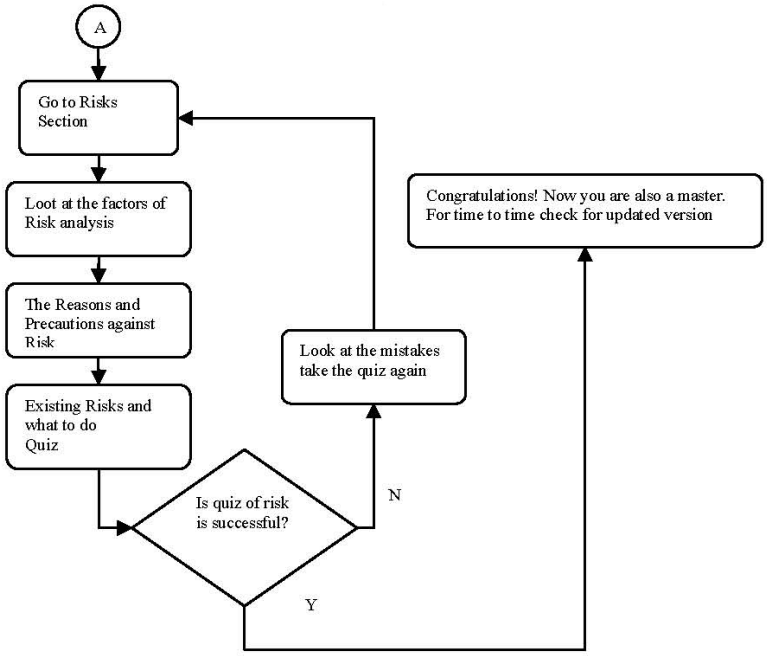

Fig. A.1B

APPENDIX 2

WebCoach questionnaire and distribution (%)

		Rate of agreement %				
		Strongly disagree	**Do not agree**	**Indecisive**	**Agree**	**Strongly agree**
Questions		1	2	3	4	5
Q1	I have learnt the basic steps essential to build a secure wireless local area networks by using the WebCoach.	0	0	18.2	36.4	45.5
Q2	The interface of the WebCoach guides me in the technical issues. I can attain the required objects by myself through this guidance.	0	0	5.9	41.2	52.9
Q3	I can decide which task to carry for each necessary step by following the system.	0	0	5.9	29.4	64.7
Q4	When I need to repeat the task, I would like to follow the steps in WebCoach.	2.9	0	8.8	35.3	52.9
Q5	If another subject is explained again by the WebCoach model, I can easily follow it.	0	0	5.9	50.0	44.1
Q6	I can comprehend the subject of wireless local area networks security by following WebCoach without needing anyone else's help.	0	2.9	29.4	44.1	23.5
Q7	What I have learned by WebCoach shows that I can easily learn the subjects that seem difficult.	0	0	17.6	50.0	32.4
Q8	Would you like to practise what you have learnt here soon?	0	0	5.9	20.6	73.5
Q9	I believe that my knowledge on IT security has increased thanks to WebCoach.	0	2.9	2.9	26.5	67.6
Q10	WebCoach makes it easy to apprehend the technical concepts.	0	0	11.8	52.9	35.3
Q11	The interface of the WebCoach guides me in the technical issues. I can attain the required objects by myself through this guidance.	0	2.9	20.6	58.8	17.6
Q13	It is easy to understand the content with the guidance in the software.	2.9	0	11.8	41.2	44.1
Q14	With this software, the difficult subjects in others courses can become easy to grasp.	0	2.9	17.6	38.2	41.2
Q15	By using WebCoach; it is easy to put into practice the theoretical information in detail.	0	0	11.8	34.2	55.9
Q16	WebCoach is a very easy-to-use software.	0	0	2.9	38.2	58.8
Q17	Following the guidance in WebCoach makes it easy to understand.	0	0	15.2	36.4	45.5
Q18	It is easy to follow the information given in the parts of WebCoach.	0	5.9	0	44.1	50.0
Q19	At which levels can this program, be used at practical courses?	0	5.9	5.9	47.1	41.2
Q20	I believe it would be useful if this system is applied to other subjects as well.	0	0	5.9	38.2	55.9
Q23	I think I can use WebCoach for other subjects under IT security.	0	5.9	8.8	41.2	44.2
Q24	I think it is a reference source that can be used in lab courses.	0	0	8.8	35.3	55.9

APPENDIX 3

Classical education questionnaire

		Rate of agreement %				
		Strongly disagree	**Do not agree**	**Indecisive**	**Agree**	**Strongly agree**
Questions		**1**	**2**	**3**	**4**	**5**
Q1	I have learnt the basic steps essential to build a secure wireless local area networks in the course.	3	9.1	18.2	51.4	18.2
Q2	I can decide which task to carry for each step in wireless local area network security by following course notes.	3	9.1	15.2	54.5	18.2
Q3	If another subject is explained again by course, I can easily follow it.	3	–	18.2	63.6	15.2
Q4	I believe that 100% security can be guaranteed by what is explained in the course.	18.2	21.2	24.2	27.3	9.1
Q5	I can take security precautions without facing any problem.	3	12.1	48.5	33.3	3
Q6	I don't face any problem after I've secured the system.	3	27.3	42.4	21.2	6.1
Q7	Before I face a problem I can figure out understand what might be the reason.	6.1	36.4	39.4	15.2	3.0
Q8	If I face any problem I can deal with it with via course notes.	–	21.2	36.4	39.4	3.0
Q9	Without consulting anybody I can solve the problems with course notes.	3	24.2	33.3	33.3	6.1
Q10	I believe that my knowledge on IT security increased thanks to course.	6.3	9.4	3.1	56.3	25.0
Q11	Narration and the course make it easy to apprehend the technical concepts.	3.0	9.1	6.1	60.6	21.2
Q12	Any information that reflects problems as risks would be usefull.	3.0	9.1	6.1	63.6	21.2
Q13	Information submitted about the reasons of risks would be useful.	6.1	–	12.1	63.6	18.2
Q14	Information submitted about precautions against these reasons would be useful.	6.1	–	9.1	69.7	15.2
Q15	It would be useful if there had been information about what to do in case of panic (when there is an existing risk).	9.1	3	3	66.7	18.2
Q16	It would be useful to explain the points separately where people had done more mistakes and understood wrong.	6.1	6.1	12.1	48.5	27.3
Q17	It would be useful if the content of the course had been prepared not only by a teacher but also by an expert group.	3.0	12.1	24.2	51.5	9.1
Q18	It would be more efficient if the content of the course had been given step by step (deduction) instead of at once.	9.1	6.1	15.2	60.6	9.1

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