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Jouni Ikonen, Harri Hämäläinen, Satu Alaoutinen, Kari Heikkinen and Jari Porras: From Tacit to Acknowledged Knowledge, 20th EAEEIE conference, Valencia, Spain, 22-24.6 2009. doi> 10.1109/EAEEIE.2009.5335485

From Tacit to Acknowledged Knowledge

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***Abstract*— This paper presents a proposal to acknowledge the importance of tacit course knowledge to students and transform this knowledge into a valuable asset. When a student or an employer reads course descriptions they usually miss a lot of important information. Course descriptions and the transcript of records normally state only the professional goals. In this paper we show an analysis of courses delivered in Information Technology department and analyze the skills, which are acquired from tacit knowledge throughout the curricula. We propose that this tacit knowledge should be analyzed, published and advertised both to students and employers.**

I. INTRODUCTION

Teaching and therefore also learning normally concentrates on subject specific, i.e. profession oriented skills. If the subject is for example (computer) programming then the stated learning outcomes normally concentrate on programming aspects like the ability to use different programming structures and languages. However what we learn during courses is not just those facts stated in outcome lists. Students learn also a lot of tacit knowledge. Most of tacit knowledge remains subconscious even for the individuals themselves. In this paper we try to identify and promote some of tacit knowledge to make it acknowledged. This requires that students realize what kind of tacit knowledge they have learned during their studies. Many of these tacit skills (or secondary or soft skills) are very important for industry employers and students should be able to advertise that they have been using or studying those skills on their courses. In our experience when students have been able to advertise for example group work skills in an interview situation they have reported that in many cases this has been more important than the actual programming skills from the course. In this paper we emphasize issues related to tacit knowledge. We want to be able to show students what kind of skills they can learn during their studies. This paper shows a way to evaluate courses for tacit knowledge.

The rest of this paper is organized as follows. After the introduction related work is discussed. In chapter III we present our approach for the course evaluation. Results of this evaluation are analyzed in chapter IV and compared to national interview in chapter V. Chapter VI presents a proposal for publicizing tacit knowledge. Finally we conclude the paper and present our future ideas for the work presented.

II. RELATED WORK

There are methods for evaluating student skills [1][2] which usually concentrate on professional subjects. Assessment is often done to evaluate student progress, as e.g. [3] describes. There exist learning communities [4] where students can act in educationally beneficial roles and learn social skills required in work life. It is important to try to close the gap between industry, which aims to “train” for business reasons, and university, which aims to “educate” for general skill set. In [5], an interesting discussion is raised in comparison of the industry certification (e.g. CISCO) and university degrees. It is concluded that both of them can support each other and it might be purposeful to integrate parts of external certificates into university curricula. In [6], a forum was built for discussion how to bring the industry and academia together. This forum concluded among others that i) business skills are as important as technical skills, ii) IT professional require a very broad skill set, iii) good oral and written communications is a must, iv) more collaboration is required between the industry and academia and v) problem outsourcing is dependant on which side of the aisle you are.

Student skills can be classified into soft skills and hard skills. Aken et al. [7] present a skill categorization in which soft skills, non-technical skills and technical skills have each four groups. The categorization contains 80 detailed skills altogether. Table 1 illustrates these categories in more details. The total number of skills is shown in parentheses. One must note that the skill set is built on ACM/IEEE IT Curricula view. Thus, e.g. their non-technical hard skills, which mostly relate to business items, are not present in our skill set. In our approach we concentrate on soft skills.

According to [8], universities are the main supplier of ICT skills demanded by the markets. The ICT industry counts on universities to produce professionals with ICT practitioner skills. ICT skills are divided into 3 categories by the European Commission [9],[10]:

1. ICT practitioner skills: these are the capabilities required for researching, developing, designing, strategic planning, managing, producing, consulting, marketing, selling, integrating, installing, administering, maintaining, supporting and serving ICT systems.

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TABLE 1
SKILL CATEGORIZATION [5]

Skill Hierarchy	Skills in Detail
Soft Skills: Problem-solving skills (#1) Interpersonal skills (#2) Work Ethic (#3) Language Skills (#4)	Soft skills (23) #1: ability to learn, attention to details, business problem solving, creativity, critical thinking, general problem solving, research skills, working under pressure #2: conflict resolution, interpersonal relationships, leadership, self-esteem, teamwork #3: motivation to work, ethics, professional ethics, responsibility, self-management, time-management #4: negotiation skills, oral communication, questioning skills, written communications
Non-technical Hard Skills: Business processes (#1) Management skills (#2) Project management (#3) Strategy skills (#4)	Hard non-technical skills (17) #1: accounting, business process engineering, contracting and legal issues, finance, marketing, SCM #2: change management, managing 3rd party providers, outsourcing management, user relationships management, working globally, working with virtual teams #3: project management / planning / budgeting / scheduling, project risk management #4: business intelligence, business strategy, project integration
Technical Hard Skills: Software development (#1) Business application (#2) Information management (#3) Hardware (#4)	Hard technical skills (43) #1: e.g. agile development, programming, communication paradigms, systems design, UI design #2: e.g. applying IT to business problems, CRM, ERP, Operating systems, transactions processing #3: data mining, data warehousing, database admin, EDI (e-business) #4: IT architecture, Network administration, security, voice/data communication
Programming skills	Programming skills (16) Both legacy languages (e.g. ADA, COBOL) and current languages

2. ICT user skills: these are the capabilities required for the effective application of ICT systems and devices by the individual. ICT users apply systems as tools in support of their own work. User skills cover the use of common software tools and of specialized tools supporting business functions within industry.
3. E-business skills: these are the capabilities needed to exploit opportunities provided by ICT, notably the Internet; to ensure more efficient and effective performance of different types of organisations; to explore possibilities for new ways of conducting business/administrative and organizational processes; and/or establish new businesses.

In [11], problem-based learning methodology was used to support knowledge acquisition and problem-solving process. The study provides good insight to knowledge construction process of students and how it can be enhanced / supported by course pedagogies. In their results, among others, is a matrix that visualizes student knowledge acquisition performance through design process characteristics, i.e. i) originality and creativity, ii) assessment and evaluation, iii) ability to implement, iv) ability to identify need(s) for design, v) choice and use of appropriate materials, vi) mastery of technological knowledge, vii) personal approach (motivation) and viii) awareness of socio-economic aspects of technical design.

Riihijärvi et al. [12] present two interpretations of the practical relevance of IT education at the university level; as the congruence between the skill requirements of IT experts and the skills provided by the education, and as the congruence between practitioners' education expectations concerning the skills to be taught and the skills provided by the education. They claim that these interpretations differ significantly, and thus lead to quite different conclusions about the practical relevance of the curriculum and education. The questionnaire is made from the viewpoint of respondent's current job and tries to identify the importance of skills in 130 topics. In their analysis the results regarding education expectations clearly show that skill requirements (e.g. men favor more programming skill, women also emphasize group work skills) are highly dependent on the respondents' background. However, education expectations are virtually independent of background.

Pulko et al. present in [13] another important viewpoint to the soft skills of engineers. They emphasize different teaching techniques instead of normal lecturing in order to improve the soft skills. In their paper they focus on presentations skills, report writing skills, teamwork and project work and improve them by using i) emphatic and captivating introduction, ii) relevant examples and storytelling, iii) group exercises, iv) brainstorming, v) demonstrations, vi) opinion polls and vii) mind breaks. The approach is quite similar to ours.

Richerson et al. present in [14] a portfolio approach that focuses on professional development transcript. They use the Accreditation Board for Engineering Technology (ABET) assessment requirements to build their transcript focusing on i) critical thinking, ii) communication, iii) leadership, iv) teaming, v) relationships, vi) comfort with diversity and vii) global interactions. Although their approach has similarities to our approach there are differences with the selected aspects as well as the usage of the information. Their approach is targeted for personal development whereas we emphasize the curricula development and better personal marketing.

III. COLLECTING THE TACIT KNOWLEDGE OF THE COURSES

Students learn many skills besides of those listed in the curricula. Many of the skills which are not in curricula help us in our everyday work life. To find out what kind of tacit knowledge students learn we made an interview form for the teachers. As the result of interviews we get a matrix of teaching methods and general skills learned. Skills used in the

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matrix are based on our believes what our students might need in their work life. The skill set can be seen as subset what is presented in [5].

Skill analysis form was divided into two main categories; *teaching methods* and *skills*. Teaching methods were further divided into *contact teaching* and *supporting methods.* Skills were divided into *personal skills* and *knowledge and social skills*. Content of these categories are presented in the following subchapters. Each skill had a specified evaluation criterion (Examples of criterion can be seen in Table 3 and Table 4).

A. Teaching methods

On this category we evaluated how many different teaching methods are used to support the learning. We categorized the teaching methods as:

- Lectures
- Demonstrations
- Seminars
- Exercises
- Practical work (e.g. laboratory work)
- In class quizzes, tests, etc.

The listed teaching methods represent contact teaching, i.e. they require some active contact between the teacher and the students. All of the methods are used in our curricula. In class quizzes category the teacher is expected to provide feedback.

The second category is the supporting methods. In these methods the responsibility of the students is increased. These methods include different types of home works as well as virtual courses where the students are required to do some activity on the net:

- Real world cases. They can contain e.g. lecturers from industry, excursions and practice sessions with industry partners.
- Online teaching (use of different learning environments)
- Home works
- Home exercises
- Home examinations
- Paper reviews, essays

For both categories the teachers were asked to evaluate how significant each teaching method is by marking how many hours was used for each method. Generally the identification of teaching methods part should be easy for teachers as the public course descriptions should already contain these.

B. Skills

In addition to teaching methods we looked at the learning outcomes and tacit (or unacknowledged) skills of each course. It was asked in the interview if the selected types (listed below) of aspects were expected from the student and how much. Teachers were supposed to evaluate the requirements based on the preset evaluation matrix. These skills were further divided into personal and social skills.

In personal skills category several profession independent aspects were selected. All these skills could be learned if practiced. Selected categories are:

- Critical thinking
- Problem solving / applying information
- Written presentation
- Evaluation and feedback skills
- Presentation skills
- Foreign language skills
- Project skills
- Programming skills
- Methodology skills
- Design (planning and modeling) skills

In social skills category we selected a set of some skills. Skills are categorized as:

- Leadership
- Negotiation
- Communications, interaction
- Group work
- Supervising

IV. Evaluation of the Results

With the help of course matrix and rating guidelines we interviewed the teachers on the department of Information Technology at the Lappeenranta University of Technology. The interview was conducted in 2005. Interviews were done face-to-face so we could explain the meaning of the interview and catch the possible misunderstandings during the interview situation.

As the result of interviews we received information about different skills used on the courses. The information was transformed to teaching method and skill matrix, which was then used to analyze strengths and weaknesses of the IT

TABLE 2
AN EXAMPLE OF COURSE MATRIX WITH SKILL ANALYSIS

Course	Contact teaching						Support methods						Personal skills and knowledge											Social skills				
	Lectures	Demonstrations	Seminars	Exersises	Practical works	Quizes	Real world cases	Virtual / online	Home work	Home exersises	Home examination	Essay / review	Critical thinking	Problems solving	Written presentation	Evaluation	Presentation	Language	Project work	Programming	Methodology	Design	Leadership / Mgmt.	Negotiation	Interaction	Team work	Supervision
Linear optimization	***		**	*				**	**				***	*							**	**				*	
Numerical analysis	**		**				*		**	*			***	*				*	*	*	***	**				*	
Mathematics 1,2,3	**		**						*				**	***							**						
TCP/IP basics	***		**	*	*					**					*											*	
Network Programming	**		**	***	(*)			*		***	**		**	***			*	***	*	***		*						
Cross media environments	***						*							**				+										
User-centric service design	*		*						**+	**+			***	**(+)	**	**(+)	*	*	*	*	**	*		+	*		*	
Distributed object programming A	**		*					*	**	**			**	**	*			*	(+)	***	*	*			(+)			
Group work course on communication software	*	*	***							***			*	**	**	**	*	*	***	***	**	**	***	***	**	***	*	
Content production	*	**							**	***		*	**	**	**+	**	**	*	***	*	*+	**	**	**(*)	*	**+			

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department's curricula. It should be noticed that there were no preset levels of each skill but this research concentrated more of the aspects existing in the curricula before taking any actions. Course matrix with skill analysis is shown in Table 2. Course names are listed in the left column and skills in column headers. On each course skills are marked with zero to three stars to identify importance of teaching method or used skills on the course. Each skill and teaching method has been given requirements for each number of stars. Plus sign "+" is used to mark that there are aspects which do not clearly qualify all the aspects for next level, but are clearly more than definition of the lower number of stars. Parentheses are used if the course has some aspect which is not completed by all students, e.g. due to a choice of assignment.

If we examine more closely how evaluation was done we find out that each category had a defined criterion which was used to give zero to four stars. Table 3 presents the evaluation criteria for the *practical works* category. This category evaluates how much practical aspect the course has, i.e. the course teaches how theory is put into practice. An example of such teaching method can be a demonstration of using some tool which is needed in work life, in which case the course would receive one star. If course has laboratory tasks where students learn to use e.g. tools needed in work life the course will receive more stars. Number of stars is dependent on how large part of the course work the practical work is. We defined that for two stars the size of the practical part is 2 to 4 ETCS and its' impact to final grade of the course is less than 40%. If two star requirements are exceeded the course will be given three stars.

TABLE 3
RATING OF PRACTICAL WORKS IN COURSE EVALUATION

Rating	Practical works
-	No practical aspects
*	There are class room demonstrations
**	Amount of practical part is 2-4 ETCS of the course and impact to grade is less than 40%
***	More than 4 ETCS of practical work and/or impact to final grade more than 40%

Another example of foreign *language skills* category evaluation criteria is presented in Table 4. On many courses the use of foreign language is required to follow lectures, to obtain research information published in multiple languages, to write papers and for presentation. In evaluation if no foreign language skills are needed the course will receive no stars. If students have to read material in foreign language the course will receive one star. If course has two aspects requiring in the use of foreign language then the course will receive two stars and if it has more aspects it will receive more stars. Each required language can be evaluated as its own aspect.

TABLE 4
RATING FOR LANGUAGE SKILLS IN COURSE EVALUATION

Rating	Language skills
-	No use of foreign languages
*	Student has to read material in a foreign language
**	Two of following: Lectures, material and examination on foreign language.
***	Student has to use foreign language in multiple tasks (lectures, written task, presentation)

An example of a course which will develop tacit knowledge on languages can be any seminar course which requires reading scientific papers which have been published on foreign language. Another example can be a practical course, where students have to build digital video recorder using Linux. In this case a lot of helpful development documentation can be obtained only in German language.

Elementary level courses are quite easy to identify from the course matrix as basic courses generally emphasize lectures (due to high number of students). Advanced level courses tend generally use larger variety of teaching methods and also require more from students as some of them simulate working life like situations. Some skill categories got alertly few hits and require more departmental consideration. Giving more attention to some skill does not necessarily mean change in curricula but just a change in or an addition to teaching methods can be sufficient.

The course matrix could also be examined from the viewpoint of graduated students (like in [15]). This way the department can use real study paths and identify skill sets, what users normally graduate with. We made a sample analysis with few graduated students and identified skills they should have practiced during their studies. In the analysis we counted how many stars were accounted for each category. Analysis does not consider the size of course. Results of two graduated students are presented in Table 5. Reader should note that we did not have skill analysis for all of their courses

TABLE 5
SKILLS CALCULATED FROM COURSES COMPLETED BY TWO GRADUATED STUDENTS

	Lectures	Demonstrations	Seminars	Exersises	Practical works	Quizes	Real world cases	Virtual / online	Home work	Home exersises	Home examination	Essay / review	Critical thinking	Problems solving	Written presentation	Evaluation	Presentation	Language	Project work	Programming	Methodology	Design	Leadership / Mgmt.	Negotiation	Interaction	Team work	Supervision
Student	**Contact teaching**						**Support methods**						**Personal skills and knowledge**										**Social skills**				
A	36	4	3	24	6	3	2	9	20	15	0	1	15	19	9	4	5	7	7	7	13	9	5	3	8	7	0
B	34	4	4	27	5	3	1	9	19	16	0	1	16	16	10	6	6	8	10	10	13	9	8	6	10	9	1

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as some of them were from other departments and some of the courses were not taught anymore. Analysis for student A and B include both 16 courses, which are 25 % and 28 % of all courses selected to be included for their degree. Teaching method columns show clearly that lectures, exercises and home work are the most used teaching methods. On skills acquired from courses the two analyzed students were taught most of:

- Problem solving
- Critical thinking
- Methodology skills
- Written presentation
- Interaction skills
- Programming skills and
- Project skills

V. Comparison of results

In Finland universities have followed up how academic (master's level) graduates get employed. In 2007 a questionnaire was send to persons graduated five years earlier. Questionnaire gives interesting insight as it also asked question about skills learned in the university and skills needed in the work. Research was nationally conducted for 14 universities, but we are mainly interested in the results related to Lappeenranta University of Technology and more closely to the department of information technology (IT)[15]. There were 59 IT graduates in 2002 and 28 of them answered to the questionnaire.

Information technology graduates were asked about what are most important skills they need in work life and how university studies prepared for them. Respondents' 11 most important skills are listed in Table 6. Skills are evaluated in scale 1 to 6, where 6 mean very significant.

TABLE 6
SKILLS TAUGHT IN UNIVERSITY VERSUS SKILLS NEEDED IN WORK

	Importance for work	University taught
Problem solving skills	5,3	4,2
Analytical and systemical thinking skills	5,1	4,4
Information retrieval skills	5,1	4,7
Organizational- and cordiantion skills	5,0	3,4
Group and social skills	5,0	4,1
Finnish skills	4,9	3,9
Information- and communication skills	4,8	4,1
Negotation skills	4,7	3,0
English skills	4,7	3,7
Project management skills	4,5	3,3
Theoretical knowledge of the study field	4,5	4,5

Respondents answered that the most important skill needed in work is problem solving, which is perfectly in line with our test analysis (with only two students). However, respondents report that university taught less of problem solving skills than they need for their job and report that the skill which university taught most is information retrieval skills. Generally the skills reported important in work life are in line with skills learned on courses.

VI. Proposal

The collected tacit information could be put into good use by combining it with other applications and information that is stored in information systems. When students enter the university and begin their studies they may have some idea, what type of characters they are, what they would like to be and learn, and what type of work they would like to do. As some of the students are more willing to do programming and others might favor co-operation or project management skills, they should be able to make a good plan that supports their strengths, skills and pick the proper courses depending on the content to achieve their goals.

When students have created the first version of their personal study plan, in the beginning of their studies, the tacit knowledge and tags related to the courses could be utilized while composing those plans. This information, compared to the expectations that the students have themselves as well as the industry has set should give the student a better idea, if the courses he or she has chosen support these needs.

The students can also use the tacit knowledge at the end of their studies or after their graduation. The transcript of records that includes the courses the student has passed and their grades do not actually describe the courses that have been participated and do not necessarily reveal the type of the course at all. Using this knowledge, person is able to give a more descriptive document or summary of the completed courses. As an example, some of the students may be marketing themselves as good group workers. In this type of cases it would be valuable to be able to present for the potential employer that he actually has been participating courses where there has been group tasks.

We propose that teaching institutions 1) evaluate all their courses for different skills and show the results to students, so it can be used as support information for selecting courses. These 2) skill evaluations should also be given to students with the grade transcripts so they can use this information to get hired. We also propose that 3) there should be generic framework for skills, so students can use this information for applying abroad. However there may be cultural differences as e.g. in some countries students might get foreign language studies in many of their courses as source material is in foreign language. We also propose that 4) course matrix is used internally to evaluate what kind of skills are taught and should some aspects be increased or decreased in teaching.

VII. Conclusions

In this paper we have shown that not only the profession oriented skills are important but non-profession oriented skills should also be considered. It seems that some of the skills are well represented in our curricula, but there is need to pay some attention to balance skills to meet the requirements of industry even better. We propose that currently tacit course

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knowledge should be identified and made public e.g. in a form of diploma supplement. This would serve the needs of both students and employers while mapping students' personal knowledge and marketing personal strengths. We will continue the identification of soft skills will continue and will be included as part of personal study portfolios [16].

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