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INTEGRATION OF LEARNING SUPPORTIVE APPLICATIONS INTO THE DEVELOPMENT OF THE E-PORTFOLIO CONSTRUCTION PROCESS

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Preface

The work presented in this thesis was carried out in the Laboratory of Communications Software in the Department of Information Technology at Lappeenranta University of Technology between 2004 and 2012. I have been supported by a great number of people during these years who have provided a good balance for my life and have always been there when it has been time for a break. You all deserve a credit and my respect for that; please note my respect and appreciation of your support. Nevertheless, there are a few persons who have had even more important role.

First of all, I wish to express my gratitude to my supervisors Prof. Jari Porras and Associate Professor Jouni Ikonen for their guidance and encouragement during my work, and for providing background on which this thesis is based on. Not to mention the several years of collaboration and the opportunity to work in various types of interesting projects over the years. I gratefully also acknowledge the contributions of each of the co-authors in the publications.

My warm thanks go to Prof. Leon Rothkrantz and Prof. Lauri Malmi for reviewing the manuscript of this thesis. Prof. Rothkrantz's comments in the earlier stage of the review gave a different perspective for the work and provided me valuable suggestions for the text. Prof. Malmi's comments were invaluable for improving and finishing this thesis, for which I am greatly thankful.

My thanks are extended to the colleagues at the Laboratory of Communications Software. During the years I had time to get familiar with number of colleagues and I remember those as good times, not least because of you. The Value Added Logistics Research team cannot be forgotten either, without that experience this book would never have been written.

I also wish to express my gratitude to my parents Hilikka and Timo who earlier encouraged me with my studies when there was the time for that. And also Jouni and Jyrki, my brothers. Unfortunately some devices in our childhood were sacrificed in the name of research and my interest to disassemble things. I am sorry for my inability to fix them.

Last but not least, I am greatly thankful for Suvi for her love and companionship. I want you to know that I am truly thankful for your and Toivo's patience during the time I have not been that visible at home. Now it is time to start spending the spare time for something more relaxing.

Tampere, October 28, 2013

Harri Hämäläinen

Abstract

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The portfolio as a means of demonstrating personal skills has lately been gaining prominence among technology students. This is partially due to the introduction of electronic portfolios, or e-portfolios. As platforms for e-portfolio management with different approaches have been introduced, the learning cycle, traditional portfolio pedagogy, and learner centricity have sometimes been forgotten, and as a result, the tools have been used for the most part as data depositories.

The purpose of this thesis is to show how the construction of e-portfolios of IT students can be supported by institutions through the usage of different tools that relate to study advising, teaching, and learning. The construction process is presented as a cycle based on learning theories. Actions related to the various phases of the e-portfolio construction process are supported by the implementation of software applications. To maximize learner-centricity and minimize the intervention of the institution, the evaluated and controlled actions for these practices can be separated from the e-portfolios, leaving the construction of the e-portfolio to students.

The main contributions of this thesis are the implemented applications, which can be considered to support the e-portfolio construction by assisting in planning, organizing, and reflecting activities. Eventually, this supports the students in their construction of better and more extensive e-portfolios. The implemented tools include 1) *JobSkillSearcher* to help students' recognition of the demands of the ICT industry regarding skills, 2) *WebTUTOR* to support students' personal study planning, 3) *Learning Styles* to determine students' learning styles, and 4) *MyPeerReview* to provide a platform on which to carry out anonymous peer review processes in courses.

The most visible outcome concerning the e-portfolio is its representation, meaning that one can use it to demonstrate personal achievements at the time of seeking a job and gaining employment. Testing the tools and the selected open-source e-portfolio application indicates that the degree of richness of e-portfolio content can be increased by using the implemented applications.

Keywords: e-portfolios, peer review, hard skills, soft skills, learning styles

UDC 37:371.3:378.147:331.535

Summary of Publications

This thesis consists of six publications dealing with the important skills of the ICT sector and the implementation of software tools concerning both the learning process and the support of personal development.

Publication 1

Harri Hämäläinen, Jari Porras, Jouni Ikonen. Integration of learning support applications in the development of e-Portfolios. *The IEEE Multidisciplinary Engineering Education Magazine (MEEM)*, Vol. 4, No. 3, 2009, pp. 76-82. ISSN 1558-7908.

This publication gives an overview of the importance of appropriate study planning and of using the resulting plan as a basis for starting to construct a personal e-portfolio. The change from an organization-centric approach towards a more learner-centric one is discussed, and e-portfolios were taken as an example of a completely learner-centric platform. The importance of external applications as information providers for e-portfolios was highlighted, and thus the importance of integration and interoperability was also addressed.

The idea for the application came from the author of this thesis. Publication 1 is written by the author of this thesis and supported by the comments of the co-authors.

Publication 2

Harri Hämäläinen, Jouni Ikonen, Jari Porras, A Tool for Visualizing Skill Requirements in ICT Job Advertisements, In *Proceedings of 7th E-learning Conference, e-Learning'11 (E-Learning and the Knowledge Society)*, August 25-26, 2011, Bucharest, Romania, pp. 254-259. ISBN 978-606-505-459-2.

Publication 2 introduces *JobSkillSearcher*, a web application which collects ICT market job advertisements from employment web sites, analyzes the content and visualizes the relationships between the terms recognized. The idea was conceived within the research group when the exploitation of e-portfolios and how they could be used to show important personal skills was discussed. Users can execute searches, and the results are presented as a trend based on the longitudinal existence of the searched term or as a graph visualizing the relations to other terms. The search results are categorized into different groups based on soft and hard skills, language skills, company names, etc.

The implementation of the application, database, manual classification of terms, and the user interface were completed by the author and supported by external modules created under the supervision of the author. Publication 2 was written by the author of this thesis and commented on by the co-authors.

Publication 3

Jouni Ikonen, Harri Hämäläinen, Satu Alaoutinen, Kari Heikkinen, Jari Porras. From Tacit to Acknowledged Knowledge. In *Proceedings of the 20th EAEEIE Annual Conference*. June 22-24, 2009, Valencia, Spain, pp. 1-6. ISBN 978-1-4244-5385-6.

This publication introduces the fact that less attention is usually paid to soft skills in higher education than to hard, technical skills. The publication presents the results related to the teaching methods and soft skills covered in courses in the Department of Information Technology at Lappeenranta University of Technology during the academic year 2004-2005. Findings resulted from face-to-face interviewing of the teachers in response to the courses. The skill set to be evaluated was constructed by the authors based on the Association for Computing Machinery/Institute of Electrical and Electronic Engineers (ACM/IEEE) IT Curricula.

The ideas for Publication 3 originated from Jouni Ikonen, Kari Heikkinen and Jari Porras, who had witnessed the insufficient methods when estimating the true outcomes of the courses in terms of teaching methods and skills. The author of the thesis participated in analyzing the results and supported the writing of the publication. The paper was presented at the conference by the author of this thesis.

Publication 4

Harri Hämäläinen, Jari Porras, Kimmo Koskinen. WebTUTOR – A Web-based Personal Study Plan Tool, In *Proceedings of 16th EAEEIE Annual Conference on Innovation in Education for Electrical and Information Engineering (EIE)*, June 6-8, 2005, Lappeenranta, Finland, 6 pages. ISBN 952-214-052-X.

This publication describes the design and implementation of the web-based study planning tool called *WebTUTOR*. Universities in Finland started to demand study plans from their students, including selected and scheduled courses. The idea for the implementation of *WebTUTOR* came from this context and from the varying habits of students in creating and presenting their plans. New and more efficient ways of creating suitable personal study plans were required, and a web-based tool for the purpose was seen as an improvement to the prevailing situation.

The author of this thesis was responsible for defining the requirements for the system (based on discussions with department personnel and students); for the design, implementation, and deployment; and for writing the publication. The paper was presented at the conference by the third author.

Publication 5

Harri Hämäläinen, Ville Hyyrynen, Jouni Ikonen, Jari Porras. Applying Peer-review for Programming Assignments. *International Journal on Information Technologies and Security*, No. 1, 2011, pp. 3-18. ISSN 1313-8251.

This publication introduces the implemented *MyPeerReview* system and the results that were obtained after its introduction at Lappeenranta University of Technology in the

spring of 2010. The benefits and utilization of peer reviewing of programming assignments were analyzed based on the results, and the benefits of using different weights for reviewers were introduced. The idea for the implementation arose from the lack of appropriate systems with satisfactory features for code peer review. The features were listed by the author of this thesis in collaboration with the second co-author of the paper. The author of this thesis supervised the implementations of the first two prototypes, followed by the implementation of the Drupal module *MyPeerReview*. The module was implemented by the first co-author of the paper and was supervised by the author of this thesis.

Publication 5 was compiled by the author of this thesis based on two earlier publications written by the author and the first co-author, with the support of remaining co-authors.

Publication 6

Harri Hämäläinen, Jouni Ikonen, Ilkka Nokelainen, The Status of Interoperability in E-Portfolios: Case Mahara. In *Proceedings of 7th E-learning Conference, e-Learning'11 (E-Learning and the Knowledge Society)*, August 25-26, 2011, Bucharest, Romania, pp. 64-69. ISBN 978-606-505-459-2.

Publication 6 highlights the importance of the interoperability of e-portfolio platforms and introduces the weaknesses of the interoperability implementation at the time research in one of the most popular e-portfolio platforms, Mahara. Existing specifications for e-portfolio contents are introduced and tests of importing and exporting are completed with two different platforms. More profound tests are completed with the Mahara platform and the problems that were identified are discussed in the paper.

The need for the research was based on the topic and needs of the author of this thesis to obtain reliable information about the current state of interoperability concerning e-portfolio platforms. The second co-author was in charge of the initial tests with the two platforms. The author of this thesis completed the tests with Mahara and analyzed the reasons for unexpected inoperability.

Publication 6 was written by the author of this thesis, with the support of the co-authors.

Within this thesis, these publications are referred to as *Publication 1*, *Publication 2*, *Publication 3*, *Publication 4*, *Publication 5*, and *Publication 6*.

List of Abbreviations and Terms

Abbreviation/Term	Full Form and/or Definition
.NET	Software framework supporting several programming languages.
ACM	Association for Computing Machinery
Ajax	Asynchronous JavaScript and XML
Apache	Open-source HTTP server software.
API	Application Programming Interface (Specifications to make software applications communicate with each other.)
CETIS	Centre for Educational Technology, Interoperability and Standards
CMS	Content Management System
CRM	Customer Relationship Management
CSS	Cascading Style Sheets
CV	Curriculum vitae
DVD	Digital Versatile Disc
ECTS	European Credit Transfer and Accumulation System (A standard for comparing the study attainments and performance of students of higher education across the European Union.)
EDI	Electronic Data Interchange
ERP	Enterprose Resource Planning
e-portfolio	Eletronic Portfolio
HBDI	Herrmann Brain Dominance Instrument (Thinking styles assessment tool.)
HFST	Helsinki Finite-State Transducer (Software for the implementation of morphological analysers and other tools based on weighted and unweighted finite-state transducer technology.)
HTML	Hypertext markup language (A set of symbols and elements used to define the content of web pages.)
ICT	Information and communication technology
IDP	Individual Development Plan
IEEE	Institute of Electrical and Electronics Engineers (Professional association for the advancement of technology.)
ILP	Individual Learning Plan
ILS	Index of Learning Styles
IMS	Instructional Management Systems
IMS ePortfolio	A specification for e-portfolio portability.
IMS GLC	IMS Global Learning Consortium
IMS LIP	A specification for e-portfolio portability.
Inc.	Incorporation
Internet	A decentralized global network connecting millions of computers. Transmits packet data with Internet Protocol.

Abbreviation/Term	Full Form and/or Definition
IQ	Intelligence Quotient
ISP	Individual Study Plan
IT	Information Technology
JISC	Joint Information Systems Committee
JobSkillSearcher	A software application for collecting and analyzing ICT job advertisements.
LAMP	Linux, Apache, MySQL, PHP
LCMS	Learning Content Management Systems
Leap2A	Learner Portfolios 2.0 (Specification for e-portfolio portability.)
LMS	Learning Management System
LSI	Learning Style Inventory
LSQ	Learning Styles Questionnaire
LUT	Lappeenranta University of Technology
MBTI	Myers-Briggs Type Indicator
MIT	Massachusetts Institute of Technology
MyPeerReview	Web-based peer review application.
MySQL	A relational database management system.
NTA	National Technical Agreement
OSBLE	Online Studio-Based Learning Environment
PCR	Pedagogical Code Reviews
PDP	Personal Development Plan
PG	Peer Grader
PHP	PHP: Hypertext Preprocessor. A server-side scripting language.
PLE	Personal Learning Environment
PLP	Personal Learning Plan
PSP	Personal Study Plan
RSS	Really Simple Syndication
SCM	Supply Chain Management
TCP/IP	Transmission Control Protocol / Internet Protocol
TAM	Technology Acceptance Model
UI	User Interface
URL	Uniform Resource Locator
U.S.	The United States (of America)
WebTUTOR	A web-based service for personal study planning.
Wiki	A website that allows editing of site content with a simplified markup language.
WWW	World Wide Web
XML	eXtended Markup Language

Table of Contents

1	Introduction.....	15
1.1	Motivation	16
1.2	Problem Statement.....	16
1.3	Methodology	18
1.4	Scope of the thesis	20
1.5	Contributions.....	21
1.6	Thesis outline	22
2	Adoption of e-portfolios	23
2.1	Portfolio construction process.....	25
2.2	Characteristics of e-portfolios	28
2.3	Classification of e-portfolio tools.....	30
2.3.1	Overview of platforms for e-portfolios	32
2.3.2	Mahara E-portfolio platform.....	34
2.4	Integrating the e-portfolio into university services.....	35
2.5	E-portfolio experiences.....	37
2.6	Discussion	38
3	Recognizing skills – the basis for personal development planning	40
3.1	The role of soft skills as a part of teaching	43
3.2	Skill requirements from the industry perspective.....	46
3.2.1	Methods of collecting skill requirements	47
3.2.2	Job advertisements as a source of hard and soft skills in demand in the ICT sector	47
3.3	Identifying skill requirements in Finnish ICT job advertisements.....	49
3.3.1	Implementing <i>JobSkillSearcher</i>	49
3.3.2	Results.....	57
3.4	Discussion	62
4	Supporting personal development planning	65
4.1	Personal study planning as a part of development planning	66
4.1.1	The role of study planning in Finnish universities.....	68
4.1.2	Providing assistance for study planning with software applications	70
4.1.3	Implementation of <i>WebTUTOR</i>	72
4.1.4	Results.....	75
4.2	Recognizing personal learning styles	76
4.2.1	Learning style models.....	77
4.2.2	Improving learning outcomes by adjusting teaching	79
4.2.3	Implementation of a web-based tool for defining learning styles... ..	80
4.2.4	Results.....	81
4.3	Discussion	88

5	Identifying personal strengths through reflection	90
5.1	Peer reviewing as a tool to support reflection	91
5.1.1	Calibration of student evaluations	92
5.1.2	System requirements for a peer review application	93
5.1.3	Implementation of <i>MyPeerReview</i>	94
5.1.4	Results from the peer review processes	95
5.1.5	Results from the peer review processes to improve self- evaluation	99
5.2	Online learning diaries	101
5.2.1	Reflection using wiki-based learning diaries	102
5.2.2	Results	103
5.3	Discussion	104
6	The potential of digitizing portfolios	107
6.1	Role of showcase e-portfolios in the recruitment process	107
6.2	Piloting the implemented applications with Mahara	109
6.3	Integration and interoperability	113
6.3.1	Interoperability specifications	113
6.3.2	Testing export/import functionalities	115
6.4	Discussion	117
7	Implications and limitations of the thesis	119
7.1	Implications for practice	119
7.2	Implications for further research	120
7.3	Threats to the validity of the thesis and limitations thereof	121
8	Conclusion	123
	References	127
	Publications	141

1 Introduction

Different end-user-driven systems on the Internet have become topical over the past decade. The term “Web 2.0” was introduced to reflect this change: masses of web users were no longer merely accessing and reading information from the web, they were also producing information. Blogs, image sharing services, community services, etc. have provided an easy way for users to share their content all over the web. The most famous of these types of services, such as Facebook¹ and Twitter², have made micro publishers out of hundreds of millions of Internet users.

While resources for the teaching and personal guidance of students in universities have become more limited, the responsibility of each student has increased. This has also had an effect on the adaptation of computer applications in universities. E-Learning 2.0 arises from the same type of phenomenon as Web 2.0. At the beginning of the past decade, educators noticed that something different was happening when students spontaneously began to use tools such as wikis and blogs in the classroom [Dow05]. Whereas the first generation e-learning solutions were mainly based on teachers’ ability to provide and share information in digital form for their students, e-Learning 2.0 relies more on the active role of students. Earlier, when students produced content, it was course assignments, typically some files that were uploaded to a server or sent by e-mail for the teacher to be evaluated. During the past decade, Content Management Systems (CMSs), such as wikis, have afforded an opportunity to share this information directly through the web and to collaborate with others. The documents and other types of outcomes can be accessed and modified by a selected group of users. Thus, the transformation from the organization- and teacher-centric approach towards a learner-centric approach is evident.

One outcome of e-Learning 2.0 is the rise of e-portfolios and the recognition of their importance. Gartner Inc. [Low11] forecasted in 2011 that the mainstream adoption of e-portfolios would have taken place in less than two years. As the e-portfolio is a learner-centric tool to collect, select, reflect on and represent personal development and skills, the responsibility for its content and the construction thereof is left to the students. The origin of the word *portfolio* comes from Latin. *Porto* means *to carry* and *folium* means *a leaf* or *a sheet*. Comparing this etymology with the practical management of the portfolios, the nature of the name is quite representative: to carry the most important pieces and demonstrations of one’s personal work for presenting one’s own skills.

Although portfolios represent respective owners’ perspectives of their personal achievements and skills, support provided by the educational institution for the

¹ <http://www.facebook.com/>

² <https://twitter.com/>

construction process can drive the construction of the portfolio more from a project-based approach towards a process-based one. Universities are capable of providing and sharing a great deal of information that may be valuable in different phases of learning and in direct relation to the learning process, which the portfolios reflect.

1.1 Motivation

The author of this thesis started to research educational technology in 2002 with the implementation of the “lecture feedback system” [Häm02]. During this ten-year period, the change from organization-centricity towards learner-centricity has been observable. Different needs for computer-based solutions and the support they can provide have emerged, and the author has been addressing those by designing and implementing software applications. The applications all share one common goal: to serve the real and existing needs of students by providing them with tools that can be used to strengthen their learning.

Portfolios can be considered a reflection of the overall learning process, whether pertaining to an individual course or an entire degree. As a framework, the construction of a portfolio, including collecting, selecting, reflecting, and representing, contains the major steps of the learning process. To support this process, existing computer applications used at the university can also be put to different use. Although the use of these applications would be driven and controlled by the university separately, they can be used to support the learning process, still leaving students with freedom of choice concerning their portfolios.

With the implemented tools presented in this thesis, students can be provided more exact information that can be used in the different steps of the learning cycle. These tools have been developed and implemented for different needs, but the information and knowledge they produce can be linked to something larger in scope: the construction of a personal e-portfolio.

1.2 Problem Statement

The construction and responsibility of e-portfolio content is in most cases left to the student. One of the challenges of e-portfolios is that the methods of construction are simple, meaning that only individual artifacts are used as outcomes of learning. If no support and help for the process is provided, the construction is usually occasional and portfolios even at their best tend to become mere data collections where learning artifacts are only stored for possible later use. In cases where portfolios are needed or demanded, the main emphasis has been on their representational aspect. This has led to a situation where portfolios are often constructed more as a project, not as a process lasting throughout one’s studies. Based on this situation, the research question is:

How can e-portfolio construction be supported with computer applications incorporated into teaching and study advising?

One of the goals of this thesis is to demonstrate that universities are already using methods related to teaching or study advising that could also be used to support the construction of e-portfolios. A simplified learning cycle from the perspective of e-portfolio construction is presented in Figure 1. On the basis of the regulations that are set in the curricula and of the occupational goals that students have, students create

personal study plans. The personal goals and preferences when students select specific courses may be affected by the topical requirements that the industry sets; for example, in the case of computer science, some programming languages are more important than others. Also, especially in later years of studies, the selections may also be partially based on the course arrangements and teaching methods to match personal learning preferences as well as possible.

After making selections and completing courses, students should reflect on their learning and also compare the results to the goals that they had set earlier. Reflection is an important step in learning and also in constructing a portfolio, but it often receives little attention. Reflection does not need to be only the students' responsibility; it can also be taken into consideration when creating the teaching plans for a single course.

Considering the cycle from the perspective of creating an e-portfolio, representation is also one of the obvious tasks. The information that has been collected in e-portfolios to represent personal development and skills needs to be organized in such a manner that it can be used to advertise personal achievements. A selection of the most important pieces of evidence can be a showcase used for industry and potential employers.

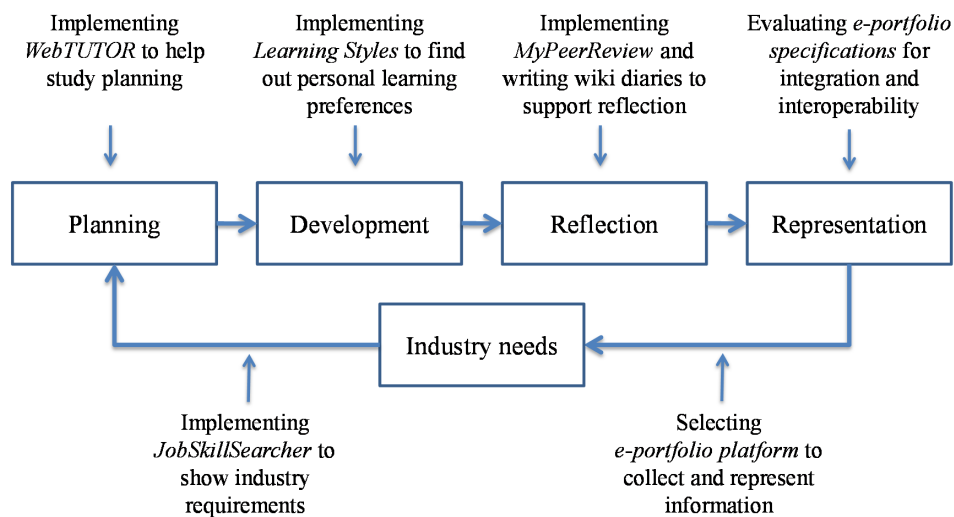


Figure 1: The e-portfolio construction process and the purpose of each implemented application.

In this thesis, the construction of e-portfolios is supported by implementing various tools for the different steps of the construction cycle presented in Figure 1. The implementation of the web-based *WebTUTOR* helps students to create personal study plans that follow the regulations set in the curricula and to schedule their studies further ahead. Since personality and different approaches for learning – which students are not often aware of – may also be one argument for selecting which types of courses students take, the *Learning Styles* tool based on different theoretical models was implemented.

To support the consideration of personal objectives and to compare these to the recognized demands of the ICT industry regarding the broad set of required skills, *JobSkillSearcher* was implemented. It automatically collects and analyzes job advertisements and the terms included. Based on the results, the skills that are typically

required in advertisements, the relationships between those skills, and also the importance of soft skills can be detected. These skills can be matched with the evaluation of skills and teaching methods in the IT courses at Lappeenranta University of Technology (LUT).

In reflection supported by self-evaluation, the ability to compare one's own results to others and to obtain peer evaluations recognizing one's own skills can be improved. Peer review processes to provide more feedback and comparisons have been carried out at LUT using the implemented *MyPeerReview*.

1.3 Methodology

The research methodology of this thesis is mainly that of constructive research, one of the most important methods in information systems research [Cap04]. It is used to define and solve problems by increasing existing knowledge through implementation of solutions for those problems. According to the original definition of Kasanen et al. [Kas93], constructive research combines both problem solving and theoretical knowledge, as presented in Figure 2, adapted from Oyegoke [Oye11]. The central part in the method, however, is the construction of the solution.

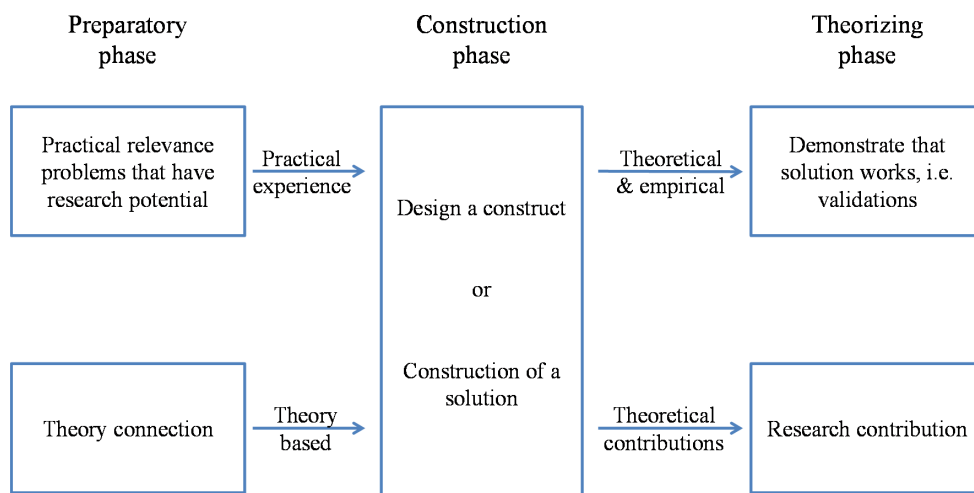


Figure 2: Constructive research approach adapted from Oyegoke [Oye11].

Constructive research starts with the identification of a practical problem needing to be solved or improved. Thus, the problem must have practical relevance. Basing the solution on prior theoretical knowledge is an essential stage of the research process to show the importance of the solution, as the research provides the researcher with an understanding of the topic in question and gives a basis for later comparison of the implementation to current solutions and to what is state-of-the-art. In other words, the problem to be solved also needs to show research potential.

The preparatory phase is followed by the construction of the solution to the addressed problem. In the context of software development, the design and implementation of the construct are included in this phase. In this thesis, the results of the construction phases are the implemented software applications.

In the theorizing phase, the final phase of the constructive research approach, applicability of the implementations is examined and the functioning thereof demonstrated. According to Oyegoke [Oye11], testing, justification, and validation can be based on quantitative and/or qualitative research. To demonstrate that the constructed solution works, empirical or theoretical approaches can be used. The novelty and scope of the application are shown by connecting the implementation to the initial theoretical research and to what theoretical contributions are provided.

In this thesis, the constructive approach can be noticed on two levels. Chapter 2 introduces the e-portfolio and the construction process cycle thereof. Shortcomings and challenges in current practices are introduced and compared to theory. The solution of the thesis author for overcoming these issues and improving this process is the identification and implementation of separate standalone applications that can be used to support the e-portfolio construction process in its different phases.

The implemented tools, *JobSkillSearcher*, *WebTUTOR*, *Learning Styles* and *MyPeerReview*, are respectively presented in chapters 3, 4, and 5, which have been organized based on the different phases of the learning cycle. For all of these implementations, existing solutions have been searched for and evaluated, which has resulted in an overview of the current state-of-the-art corresponding solutions (at the time of the research) and weaknesses that have been observed. Comparing the existing needs to the current solutions has revealed the *practical relevance* of the designed applications. Literature reviews have been completed concerning the *theoretical approach* to finding a connection to the existing theory and to taking the previous findings into consideration when later deciding about the important functionalities needed.

As implementation of the tools is the fundamental stage of the constructive research, the *construction* of the applications holds a central role in this thesis. New implementations or improvements to existing ones were required for the majority of solutions introduced in this thesis. The construction is presented in the sections where the tools are introduced and in the publications included in this thesis.

Following the construction of applications, the *practical functioning* of the implementations was studied by introducing the tools to the students and piloting them as part of study guidance and teaching. The results that were collected were analyzed with different methods. The significance of *WebTUTOR* for personal study planning was evaluated by interviewing five students who had used the tool to construct their plans. For the evaluation of *JobSkillSearcher*'s being able to recognize terms from the advertisements, a group of five researchers was used to analyze the content of advertisements manually. Reliability was calculated using Krippendorff's alpha to find out the level of internal consistency of the results. Pearson's correlation coefficient and Spearman's rank correlation were used to calculate the correlation between the results of *JobSkillSearcher*'s findings and LUT alumni survey. The effect of students' personal learning styles on participation in different types of courses and students' performance in courses were calculated using T-tests. Pearson's correlation coefficient and Cronbach's alpha were calculated to see the effect of peer-review on self-evaluation.

Empirical research on the advantages and experiences of the developed applications was conducted with surveys and by comparing the results to the existing scientific results. The *research contribution* of the tools stems from the knowledge and

information gained as outcomes of using the implemented tools, and the novelty that the tools have compared to the existing solutions. Many of the tools have features that can be used for their primary purpose but also for collecting information of scientific value. Also, the theoretical value of the tools is discussed from the point of view of improving the e-portfolio construction process. The relevance of the tools to the construction process is discussed at the end of each chapter.

1.4 Scope of the thesis

The term “portfolio” is usually used to describe the whole range of different types of portfolios, such as documentation portfolios, reflective portfolios or showcase portfolios, not concentrating on only one of the purposes or approaches. This type of an approach is sometimes called a hybrid portfolio. Since e-portfolios have the potential to combine the usually separate purposes of learning portfolios, assessment portfolios and employment portfolios [Pen06], a comprehensive approach that takes the different aspects of portfolio construction into account has been adopted in this work. When considering the use of e-portfolios, the term “e-portfolio” in this thesis relates to applications that are accessible through the web. Therefore, “Webfolio” [Ski05] is also occasionally used to describe web-based portfolios.

The types, production and representations of artifacts can be diverse, even when the artifacts only pertain to computer science. They can be executable computer applications, source code thereof, technical documentation, presentations, etc. Therefore, the production and usage of the artifacts produced as evidence of learning outcomes is not dealt with in this thesis. Instead, what the author considers more important and significant from the university perspective is the support that can be given to students in other phases of the learning process. This comes in the form of providing tools (and thus help) for setting personal objectives, for learning more about the different approaches to learning, for using this information to create personal plans and goals, and for yielding better conditions for reflecting on one’s own learning and knowledge.

This thesis does not cover all of the technical or pedagogical aspects involved in the construction process of portfolios and the integration of different tools into it. Neither does it create solutions or improvements to learning or portfolio ontology, although ontologies do have an important role to play when one considers skills (and by extension e-portfolios). However, the approach – also in the integration of the applications – deals more with recognizing and implementing solutions to support the construction process, yielding tangible examples and providing an opportunity for their integration into e-portfolio platforms based on existing specifications and experiences of the existing solutions.

Collaboration is not taken into account or evaluated when one constructs a personal portfolio. For instance, even though construction of a wikibook is cooperative, the effect of collaboration on the process is not considered in this thesis. Extensive collaboration would also introduce another topic: ownership of the information produced. With the narrow scale of collaborative aspects in this thesis and the applications presented, the guideline in the courses where the tools were used was that the information produced and feedback given could freely be used for personal purposes, e.g. using the peer reviews received to advertise one's own accomplishments.

In this thesis, the main emphasis is on university-level computer science students. However, the implemented applications are fully available or at least modifiable to be used at different levels of education and science degrees, and the approaches for improving the process should apply to other environments, as well.

1.5 Contributions

The core contribution of this thesis is the implementation of the presented software applications and the identification of their relationship and importance to supporting the steps in the e-portfolio construction process. Although the applications that form the structure of the thesis are standalone systems, the knowledge and information produced from using them can directly be connected to this process. The selected e-portfolio platform, Mahara³, is used as a tool where the learner-centered portfolios and information can be collected. Although partly driven by the university, the personal portfolios and their construction are not controlled by university authorities or any other parties. Therefore, based on the research presented in this thesis, the author claims that implemented software applications used as a part of teaching and study guidance practices can be integrated into the e-portfolio construction process to enrich the meaningful content of students' e-portfolios.

The use of the applications presented in this thesis is managed by the university, and the tools have a role in either teaching or study guidance purposes. Although these tools are primarily used to support different teaching methods or study advising, the outcomes and information gathered from them relate to the knowledge of the construction of an e-portfolio, thus supporting the entire process.

The purpose of this work is not to focus on the creation of impressive showcase e-portfolios. The e-portfolio and its platform are used as a framework where information can be collected easily. However, in order to be able to demonstrate that the integration of these applications is also technically implementable, the open-source e-portfolio application Mahara was considered as a potential platform for maintaining e-portfolios in the future. In addition, the Leap2A specification was considered as a potential solution to support interoperability and to model the information that is provided by these tools.

The contributions of this thesis are the implemented applications and the verification of their usefulness, and the linking of them to supporting the construction of e-portfolios. Before the implementation of these applications, research was conducted on existing applications that would meet departmental needs and provide us with the required functionality. The implemented applications have been used by IT students in selected courses at Lappeenranta University of Technology, and improvements have been made based on the users' experiences. The results of the use of the applications were examined both from the university perspective and from the students' perspective.

Although portfolios have been constructed for decades, especially in the humanistic sciences, digitalization has brought along challenges. Often, the e-portfolio platforms are only used as data depositories, where artifacts are stored but not organized or defined properly. This can be improved by giving instructions or even by evaluating students' e-portfolios. However, since portfolios should remain learner-centric

³ <https://mahara.org/>

collections, intervention in the construction can guide the results too much towards institution-centricity. Therefore, these tools have clearly been separated from the actual platform where the artifacts are collected. However, the same applications and the information and knowledge that they provide can be used to support the e-portfolio construction process. The importance and relevance of the outcomes as a part of improving the e-portfolio construction process lean on learning and portfolio *theories*.

1.6 Thesis outline

Chapter 2 introduces the concept of e-portfolios, the importance of the process-based approach in their construction, and the basis for their adaptation in an academic environment. Chapter 3 discusses the importance and means of recognizing skills for a personal career and development planning and introduces a tool for collecting and visualizing skills from job advertisements. Chapter 4 presents tools for personal development planning supported by study planning and recognizing personal learning preferences. Chapter 5 discusses the role of reflection in personal development, familiarizing students with reflection using personal learning diaries, and supporting it through peer review (as a part of teaching). Chapter 6 describes the collection of experiences of the importance of showcase e-portfolios in recruitment and the technological requirements for taking lifelong learning into account in the e-portfolio process. Chapter 7 discusses the implications and limitations of the thesis, and chapter 8 concludes this thesis.

2 Adoption of e-portfolios

At times, people must be able to estimate and demonstrate their skills, and use this information in decision-making. Examples of these types of situations include students making decisions about which courses would best support their existing skills or students looking for a job. Portfolios have been used to collect, organize, document, reflect, and represent personal skills, achievements, and experiences. The results of projects and work completed during studies can be collected into portfolios as evidence of what has been learned. Compared to academic transcripts with the names of completed courses and grades, portfolios focus more on personal development. One's most valuable achievements and personal reflection thereupon are used to improve personal development and re-focus personal goals.

The primary purpose and emphasis of the use of a portfolio may be identified according to the various definitions for portfolios. Different terms and types for portfolios are presented in Table 1. The e-portfolio specification of the IMS Global Learning Consortium [IMS05] has categorized portfolios into six major types often referenced in the literature: assessment ePortfolios, presentation ePortfolios, learning ePortfolios, personal development ePortfolios, multiple owner ePortfolios, and working ePortfolios. Different terms with the same meanings, such as documentation portfolios, process portfolios and showcase portfolios [Hew04], are also used to describe the primary purpose of a given portfolio. All of these different purposes for e-portfolios and contexts in which they can be applied make implementation challenging [Joy09]. Nowadays, the most widely used approach for e-portfolios and their implementation is a combination of these characteristics, which can be referred to a hybrid portfolio [Bal10c].

Table 1: Major types of e-portfolios.

<i>IMS GLC definition</i>	<i>Synonym</i>	
Assessment ePortfolio		Hybrid portfolio
Presentation ePortfolio	Showcase portfolio	
Learning ePortfolio	Documentation portfolio	
Personal development ePortfolio	Process portfolio	
Working ePortfolio		
Multiple owner ePortfolio		

Considering all the different fields of study and professions, preference for different portfolio types is natural. Whereas architects may primarily use their portfolios to show their earlier achievements using examples and medical students may use their portfolios for assessment purposes, a computer science student may view his portfolio as a type of service whereby achievements can be stored and accessed later for personal needs. A

programming code of good quality can be reusable on many occasions and can be easily accessed from a web-based portfolio.

Modern information technology permits a considerable amount of information to be stored electronically, allowing for various advanced features and operations to be used to manage portfolios. The use of electronic systems, such as personal learning environments, makes it easier to present data in e-portfolios. With regard to university students, the e-portfolio may be a collection of personal achievements and tasks that have been completed during one's studies and stored in digital format. In such a case, the portfolio may also be categorized as a learning, development, or documentation portfolio. When a student wants to publish some parts of it using digital media to represent personal skills and experience, it can be referred to as a presentation or showcase portfolio [Lor05]. The selection of the parts that are published in a single showcase portfolio depends on who is the target audience for the portfolio; only the most relevant parts for the complete portfolio are selected to avoid mixing important with less important information.

A consensus has not been reached as to who should have control over the portfolios, although the role of the learner as a primary stakeholder is agreed upon. Barrett [Bar04] has compared the effects of ownership for the portfolios: whereas portfolios controlled by an organization mostly concentrate on the content, portfolios controlled by learners engender, in addition to the content, the purpose and process of constructing the portfolio. Portfolios controlled by organizations are in danger of ending up being online assessment systems. The motivation and needs of constructing the portfolios also differ depending on the experience of the learners; in the beginning there is typically more need for guidance, whereas more experienced learners are more self-directed. Ritzhaupt's [Rit06] goal has been to find a way to provide the students with as much control as possible, but still keeping in mind the importance of meeting the organizational goals. Wade [Wad96] has also categorized the possible roles of the portfolio based on purpose, whether it is used as a form for alternative assessment of students or whether it should be more of a student-centric tool emphasizing students' reflections and providing opportunities for their choices. This approach is presented in Figure 3, sketched by Cross [Cro97].

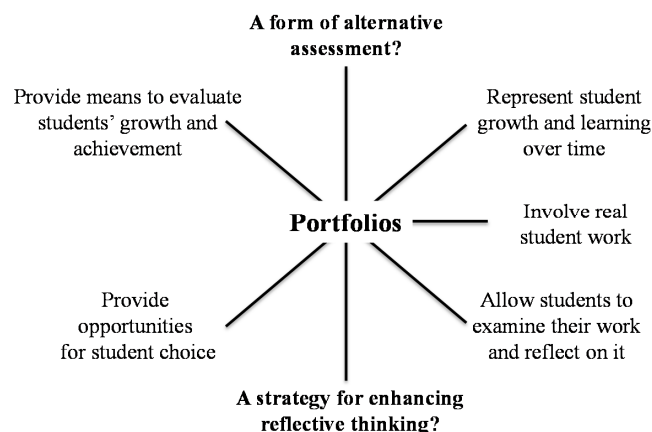


Figure 3: Possible roles and purposes for portfolios [Cro97].

2.1 Portfolio construction process

Working with portfolios is not merely a question of tools and platforms used to manage and construct them. In addition, a sustainable measure to support self-directed learning is needed [Hil07]. This can be approached by reviewing the learning process more closely. Efficient learning requires both identification of the goals to be pursued and good evaluation of existing skills. Honey and Mumford [Hon95] have divided the learning process into steps in their model of learning styles. Learners with different emphases and abilities have been placed in the different parts of the cycle, which is presented in Figure 4. The iterative cycle is divided into four parts: having an experience, reviewing it, concluding from it, and planning the following steps.

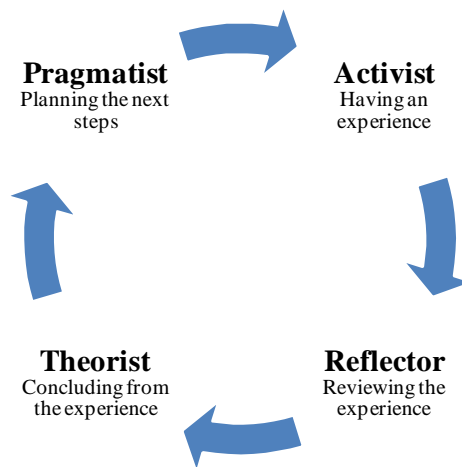


Figure 4: Learning cycle according to Honey and Mumford reproduced from [Hon95].

Honey and Mumford's learning cycle presents a basis for approaching the process of portfolio construction, since all the steps may be linked to that process as well. For preparing personal portfolios, different processes and steps have been proposed. The four most common high-level steps of the construction are:

1. **Collection** (of artifacts). This is typically completed during the activist phase of having an experience or after it.
2. **Selection** of the most important artifacts is done during artifact collection or after the collection thereof.
3. **Reflection** involves reviewing one's achievements.
4. **Representation** helps in concluding from the experience.

Sometimes other actions, such as the connection to finding ties between the disparate parts students have done and learned, are also included [Kim05]. Burke et al. [Bur94] have created a more extensive and detailed definition by identifying ten stages of portfolio development to enhance the quality of the process:

1. **Project** purposes and uses

2. **Collect** and **organize**
3. **Select** valued artifacts
4. **Interject** personality
5. **Reflect** meta-cognitively
6. **Inspect** and **self-assess** goals
7. **Perfect, evaluate, and grade**
8. **Connect** and **conference**
9. **Inject** and **eject** to update
10. **Respect** accomplishments and **show pride**

These stages can be used to divide the steps into more specific areas that can be supported by computer applications. The applications to support these steps can either be included in the collective platform, the external computer applications that support selected individual steps, or the learning management systems that may consist of functions supporting several of these steps and may be managed by the university.

Figure 5 presents the flow and the process of portfolio construction, with links to the publications included in this thesis. The cycle starts from the needs expressed by industry; then proceeds to planning, development, and reflection of learning; and ends by presenting this information again to industry. For a student, the possibility to see and realize the relations transparently between the parties who have an interest in the portfolios, including industry, is important for successful adaptation. If students are unable to see and figure out these relationships between the stakeholders, their responses in varying contexts may be skewed [Rit06]. This can be improved by emphasizing e.g. the role of industry and by sharing the industry requirements with students.

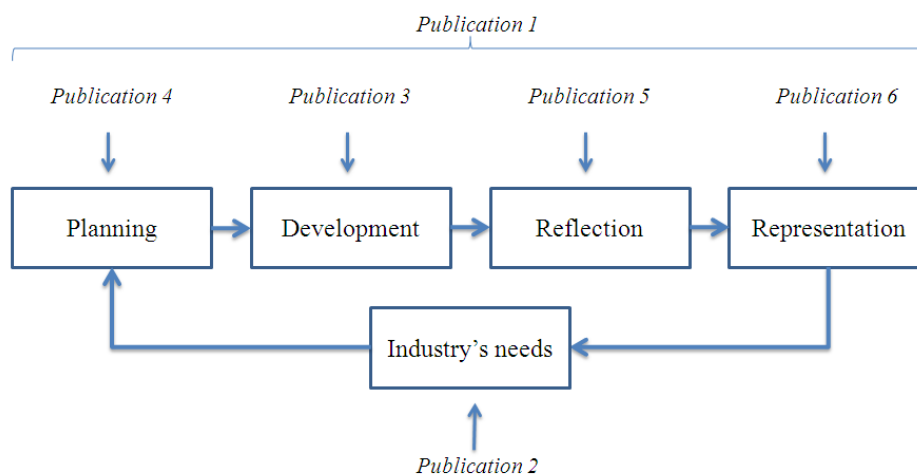


Figure 5: Iterative phases of portfolio construction.

The stages of portfolio development also apply to e-portfolios, but the possibilities that the computer applications provide have to be taken into account in order to advance the process with new potential tools. Using separate tools to support the stages of the process and to produce information can help the students to focus on these stages. The e-portfolio and its construction process can be used as a framework to connect these outcomes and to show the benefits of the implemented applications. The supporting tools do not have to be used only as a part of teaching as advanced software, but rather as tools that 1) support the learning cycle by applying some theories in practice and 2) support and improve the construction process of the e-portfolios, thus leading towards better and more advanced planning and control of an individual's personal development. The use of portfolios in engineering education is still quite limited, but by creating a stronger link from the tasks and applications to personal portfolios, its use can be promoted.

Various tools are already being utilized to create content used not only to fulfill educational requirements, but also to represent personal achievements which can be shared with the community. Figure 6 presents the details of the stages during studies of a larger scale, and is partially based on Honey and Mumford's learning cycle. Different applications and their outcomes are linked to different stages of the learning and e-portfolio construction cycles. The stages in the figure are roughly divided into three areas from the perspective of the application: planning, creating artifacts (experiencing) and representing (concluding from the experience). Reflection in this case is related to all of these stages.

In each of these stages, there are tasks that have learner-centric and organization-centric approaches. Taking the stage of planning as an example, the organization-centric approach consists of creating a personal study plan which includes the selected and scheduled courses based on the degree curricula. The learner-centric approach to the same stage means having a personal development plan, including which job positions are to be attained and which skills should be obtained to fulfill the requirements of these positions.

Reflection is a task that covers all of these stages. As learners have devised a plan for their development, they should reflect on their learning outcomes and achievements as well as on the evaluations against their objectives. After reflecting on one's skills and thus conceptualizing one's personal know-how, the representation of skills becomes easier when an employer has to be convinced about the learner's personal abilities.

Even if the learning process is supported by the university, all of the tools and information needed to extensively cover all of these stages are not. The role of external third-party applications in producing artifacts and collecting information is remarkable, especially now with Web 2.0. These applications, some examples being presented in the right-hand side of Figure 6, can also be connected to the construction process of e-portfolios. The topic was discussed in *Publication 1*.

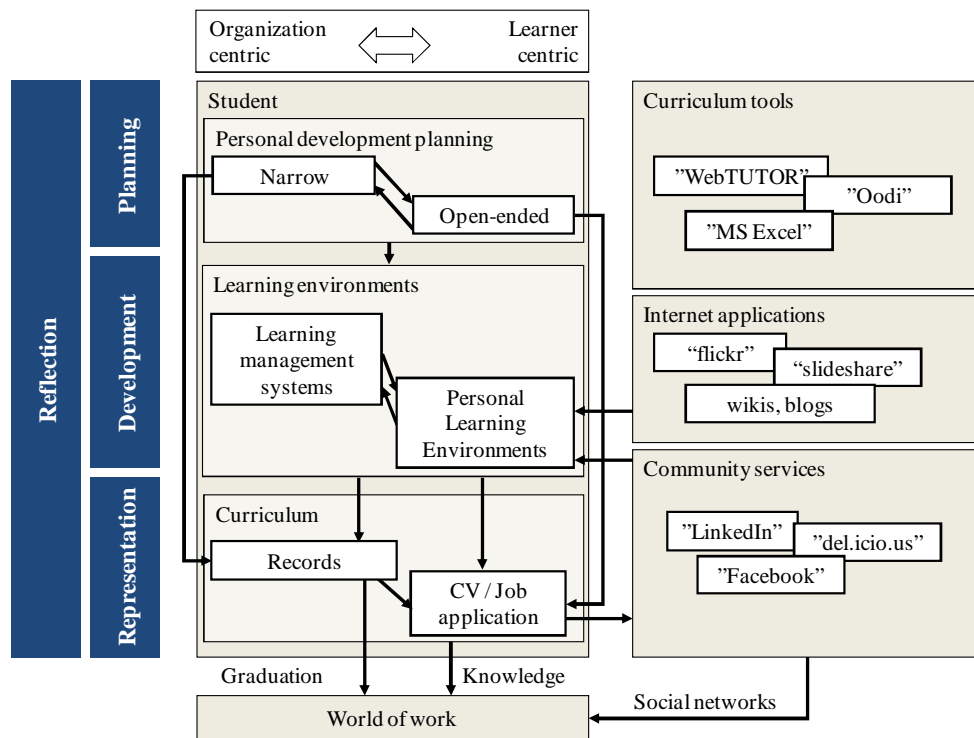


Figure 6: The relation between e-portfolio construction steps, learning, and external applications, from *Publication 1*.

The contribution of this thesis comprises separate tools and results that are related to the construction of e-portfolios in a supporting role. The applications are not implemented as a part of a certain e-portfolio system, but instead as external standalone applications. This is because of two reasons. Firstly, when creating software applications to support study guidance and learning on the basis of this research, binding the application implementations to and being completely dependent on a single platform leads to unreliability. Secondly, if e-portfolios are considered completely learner-centric outcomes and tools, importing the evaluation process and control to the level of e-portfolios reduces the degree of learner-centricity. Therefore, the evaluation of artifacts is not performed through an e-portfolio, thus minimizing the role of the assessment of e-portfolios.

This thesis refers to the construction of a portfolio as fundamentally based on gaining a comprehensive and competitive set of skills, recognizing them, collecting artifacts to prove these skills, and recognizing their value. To be competitive, the requirements set by industry need to be covered at least to some extent. This provides a good starting point for personal development planning.

2.2 Characteristics of e-portfolios

At the beginning of the e-portfolio era, the characteristics and requirements set for e-portfolio systems did not dramatically differ from traditional printed portfolios. Four basic portfolio characteristics listed by [Ham98] highlight the potential that electronic tools have to transform existing information into knowledge:

- Portfolios can feature multiple examples of work.
- Portfolios can be context rich. In addition to text and still images, different forms of information, such as video and audio clips, can be used. Detailed descriptions and metadata can also be included.
- Portfolios can offer opportunities for selection and self-assessment.
- Portfolios can offer a look at development over time.

With the introduction of electronic systems to support portfolio construction, a wide variety of functionalities connected to the features of e-portfolios and the systems used for their construction has become available. The functionalities for searching and organizing information also make a considerable difference between one-dimensional collections of artifacts/data warehouses and real e-portfolio platforms. Hilzensauer et al. [Hil06] have listed some possibilities offered by e-portfolio systems:

- Integration of a large amount of digital artifacts addressing different senses in different media formats (e.g. text, pictures, sound, video, animation);
- Displaying artifacts flexibly, adjusting them to different contexts and re-using them for different purposes;
- Chronological documentation and presentation of a learner's biography;
- Initiation of the learning process in groups with web-based collaboration tools;
- Intensive participation and transparency in the reflection process.

For example, these features give users full control over managing and organizing their personal e-portfolio and using it to track personal development and learning. Different sections of the e-portfolio can be used to personalize job applications and provide additional proof of personal achievements and skills. Personalization guarantees that users have the opportunity to adjust their showcase portfolios to better fit the position applied for [Lor05].

Since accessibility for the content of portfolios has improved, the process-based approach may also receive more attention. Just as e-learning tools were advertised a long time ago as being independent of time and place, portfolios experience the same phenomenon. Because portfolios are no longer printed documents, the likelihood of their being accessed and maintained with greater passion is increasing.

The representation of artifacts involves the selected pieces of information to be shared with a targeted person or group, often a potential employer. This entails a requirement for categorizing and classifying the information to facilitate the examination of the information. Although gathering the skills and knowledge is mostly based on a non-specific level of requirements, applying for a job is always an independent and customized assignment which corresponds to the questions and requirements of that particular job. Therefore, the vital role of the tool for analyzing information about job advertisements is not for supporting the employment process and applying for a job; instead, it aims to provide information to students in earlier stages of their studies to

support their decision-making and give them a better idea of the requirements that they will encounter later on.

Clark and Eynon [Cla09] have listed four major drivers of e-portfolio use. The first is the growing interest in student-centered active learning, which triggers a pedagogical change. The second is the dynamism of digital communication technologies, as the capacity to document and publish diverse forms of learning has lately grown dramatically. The third is increased accountability, or linking student work to institutional or disciplinary competencies, facilitating a more classroom-based and faculty-driven alternative to traditional assessments. The last driver is the increasing fluidity in employment and education. Students – and professionals – need to be able to represent their learning and carry it with them as they move from one environment to another. In terms of technical aspects, the last driver highlights the importance of interoperability.

2.3 Classification of e-portfolio tools

Ever since different software applications have provided the opportunity to collect information, they have been used to fabricate portfolios. Tools that have been utilized for word processing, creating presentations, etc. have offered a basis for collecting personal experiences. Being only one-dimensional applications without specific functionalities, the e-portfolios created with these types of tools have primarily been created for a single purpose, such as the representation of one's achievements or reflection of one's learning. The different cycles of portfolio construction are not taken into account within these tools, as they are used for creating artifacts or managing content.

Since varying applications and platforms have been used for creating e-portfolios, there is a need to classify these tools and approaches. Depending on how extensively the substantial functions of the process are taken into consideration, different approaches to classifying the available tools have been proposed and taken. A fairly free-form and high-level, but still extensive classification of e-portfolio tools by Barrett [Bar07] gives an idea and a good starting point for seeing how wide the variety of tools and approaches can be. Barrett has divided the tools into two major categories, each further divided into three subcategories:

- **Individual tools**
 - *Authoring tools.* These tools are used offline to create content for representative purposes. For example, FrontPage can be used to create and edit content for web pages; Word or MovieMaker to create artifacts. The products of these tools require external web space for publishing or they can be published in physical media, such as DVDs. No interactivity is included.
 - *Static Web Services.* Online hosting services are used to create, publish, and share prepared portfolios. No interactivity is included, unless the user implements and manages scripts.
 - *Interactive Web Services.* Web 2.0-based dynamic services that allow creating and publishing content. They are run on installations of CMSs

or platforms which users can manage on their own. Blogging services, Google's tools, etc. belong in this category. Interactivity is possible.

- **Institutional tools**

- *Web-based services.* The institution provides the service for its students and manages the platform in its own server. Typical e-portfolio platforms Mahara and Elgg⁴ fall into this category when provided by the institution. These services are interactive.
- *Hosted services.* Systems that the institution adopts to host portfolios from external service providers. Google Apps for Education⁵ and PebblePad⁶ represent this type of tool. These services are usually interactive.
- *Hosted assessment systems.* Hosted systems that also include data management for the purposes of institutions. Interactivity is included in these systems.

When observing this classification, the emphasis has clearly been on the representative role of portfolios. When one uses individual tools, there are no methods or guidance for focusing on the process and its importance, or for bundling together the supportive tools. As Barrett has mentioned earlier [Bar99], a portfolio without standards and reflection is just a multimedia presentation, a fancy electronic resume or a digital scrapbook. If we take a look at the previous classification, many of these categories can be seen to be leading precisely towards that kind of result.

Slightly different and more restricted classifications are provided by Hilzensauer et al. [Hil07] and Ivanova [Iva08]. Hilzensauer has divided e-portfolio software into three main categories: 1) independent e-portfolio software products; 2) learning management systems with e-portfolio functions; and 3) social software, Web 2.0, and social networking tools. Ivanova's classification is congruent, but a bit more extensive. It includes:

- Commercial e-portfolio software systems;
- Open source software products;
- Learning management systems with e-portfolio functions;
- Content management systems with e-portfolio functions;
- Integrated systems and software families.

Kim et al. [Kim10b] have proposed a completely new design for e-portfolio systems based on cloud computing. Their proposal for e-portfolio system design is based on the Private-Public Data Index system, which integrates cloud computing applications and

⁴ <http://elgg.org/>

⁵ <http://www.google.com/a/edu/>

⁶ <http://www.pebblepad.co.uk/>

storages with Semantic Web architecture. With the semantic approach, the possibility exists to make student learning artifacts more understandable to computers. The issues of e-portfolio transportability can also be solved with this type of approach.

For the long term, interest is squarely focused on institutional web-based systems providing good accessibility to information. For the institution, providing these tools results in the opportunity to influence the construction process of students' e-portfolios. Considering the implemented open-source tools to support the process presented in this thesis, the expandability of the platform in many cases serves the needs of the institutions for customizing the tools and enabling the integration of separate tools into the platform. The university's having control over the management of the application will probably provide better changes for transferability of the portfolios when the technological solutions are advanced enough to guarantee this.

2.3.1 Overview of platforms for e-portfolios

Within the categorization presented earlier, diverse tools have also been proposed and tested for the construction of e-portfolios in academia. Google Apps provides a wide range of tools that can be used for the creation of artifacts and also for the representation of the information produced. Casquero et al. [Cas08] have used iGoogle and gadgets for integrating institutional and external services, Rodríguez-Donaire and Amante [Rod11] have evaluated the usability of Google Sites as a platform for constructing e-portfolios. Furthermore, Hodson et al. [Hod10] have conducted a survey including the evaluation of wikis as a platform for building a personal e-portfolio. Montgomery [Mon04] has even proposed using Microsoft Office PowerPoint for creating e-portfolios.

CMSs are a step towards easy-to-use and centrally managed platforms where users can individually manage and store their information. Wordpress⁷, Joomla⁸ and Drupal⁹ all have the technical features to enable personal spaces for collecting the information and artifacts. The problem within these systems is that they do not have modules that would support the vital parts of portfolio construction, such as reflection and planning. Also, creating numerous different views of the existing information is not necessarily supported.

In addition to the above-mentioned systems that can be shaped to manage the information collected for portfolios, there are solutions that have been tailored to the construction of portfolios. Moofolio¹⁰, an additional module for the popular Moodle¹¹ Learning Management System (LMS), is an example of an add-on to an existing system. Having the e-portfolio functions as a part of an LMS makes embedding of existing information into a personal e-portfolio simple.

The most comprehensive e-portfolio solutions, such as Mahara and PebblePad, have been developed particularly for the construction and needs of e-portfolios. The emphasis of these tools is often on representation of the information in the personal portfolio, including the steps of collecting and arranging the information. Also the steps of the construction process, such as reflection, have been made more visible for users.

⁷ <http://wordpress.org/>

⁸ <http://www.joomla.org/>

⁹ <http://drupal.com/>

¹⁰ <http://www.k12opensource.org/spdc/moofolio/moofolio.html>

¹¹ <http://moodle.org/>

Since the development and adoption of e-portfolios has still not reached its peak, new innovations to improve the use of e-portfolios emerge from time to time. These applications typically try to take the different stages of the portfolio construction better into account. Wong and Mann [Won10] have introduced a tool which has been implemented as a part of Blackboard LMS and includes mobile technology for developing reflective portfolios.

Shroff et al. [Shr11] have analyzed the technology acceptance model (TAM) to research the usefulness and ease of use of e-portfolio systems by sending a questionnaire to students. Their results indicate that the ease of use had a significant influence on the attitude students had towards the system. Subsequently, ease of use had the strongest significant influence on the perceived usefulness. Based on these experiences, TAM is considered a good theoretical model, even in an e-portfolio context.

Himpsl and Baumgartner [Him09] have extensively evaluated e-portfolio software based on the taxonomy they created and used to evaluate individual tools. They included e-portfolio management software, LMS and learning content management systems (LCMS) with integrated e-portfolio functions, CMS with indirectly available portfolio functions, and other systems that can be used to construct e-portfolios. A panel of 25 e-portfolio experts assessed the importance of the criteria, after which all of the products not fulfilling the essential criteria were excluded, and finally, a deeper analysis was carried out. Based on their evaluation, PebblePad, Mahara and Taskstream¹² represent the top-quality applications in view of the criteria of the supporting portfolio process. A common denominator for these three applications is that they have been developed as e-portfolio applications, but Mahara is the only open-source application of the three. The applications and their final evaluation scores are presented in Table 2. Based on the qualitative analysis of the results, all of the categories were rated with a score from one to three, three representing an explicit recommendation in the respective meta-level category.

¹² <https://www.taskstream.com/>

Table 2: Combination of evaluation scores [Him09].

Product	Portfolio features			Technical features			License	Product type
	Collecting, organizing, selecting	Reflecting, testing, verifying, planning	Representing, publishing	Effort for the first time installation	Administration	Usability		
PebblePad	3	2	3	3	2	2	PU	E
Mahara	3	2	3	3	2	2	OS	E
Taskstream	2	3	3	2	1	2	PU	E, I
Factline	3	1	3	2	1	1	P	I
Frontier	3	2	1	2	2	1	U	L, I
Drupal ED	3	1	2	1	3	3	OS	I
Elgg	3	1	2	2	3	3	OS	O
Sakai	2	1	3	2	3	2	OS	L, I
Movable Type	3	1	2	1	3	2	OS	I
Wordpress	3	1	2	2	2	3	OS	O
Epsilen	1	2	1	3	1	1	PU	E
Exabis	1	1	1	3	3	2	OS	L

P = Commercial with all-inclusive offer

E = E-portfolio management software

U = Commercial with licenses per user

L = LMS with integrated E-Portfolio functions

OS = Open-source

I = Integrated systems respectively software families

PU = Commercial with a combination of P and U

O = Other systems, respectively kinds of software

Balaban and Bubas [Bal10a] later researched students' evaluations of the two open-source e-portfolio systems, Mahara and Elgg, based on their maturity, purpose, typology and potential for student reflection. Mahara was favored by their students, and actually received better evaluations on each of their survey items, all of which were mostly related to the user experience. Mahara seemed to outperform Elgg because of its simplicity and universality in terms of e-portfolio functionalities. Prasad et al. [Pra10] also recommended Mahara because of its easy installation and integration with Moodle.

2.3.2 Mahara E-portfolio platform

Since the research results affirm the good quality of Mahara and since LUT experiences with Mahara have supported it, the decision was made to use it as a basis for considering the capabilities of current e-portfolio platforms. Mahara is being developed towards a more modular architecture, which has opened up the potential for external plug-ins and developers. Although Mahara is a fully operable standalone system, its role as an additional tool for Moodle has also been considered.

The learner's front page of Mahara contains three activity types that can be considered to stem from portfolio pedagogy and the learning process. *Create and collect* is used to develop the portfolio, i.e. to manage one's personal profile, to upload files, to create a resume and to publish. *Organizing* is used to create different views of the information for different needs and audiences. Keywords and meta-information of the existing elements can be used to help organize the content. The user can create an unlimited number of active views, and access to the views is controlled by the user. *Share and Network* is the third activity type and is related to the social aspect and privacy settings.

The user can network with friends, and join in and create groups. These three topics are separated into their own areas in Figure 7.

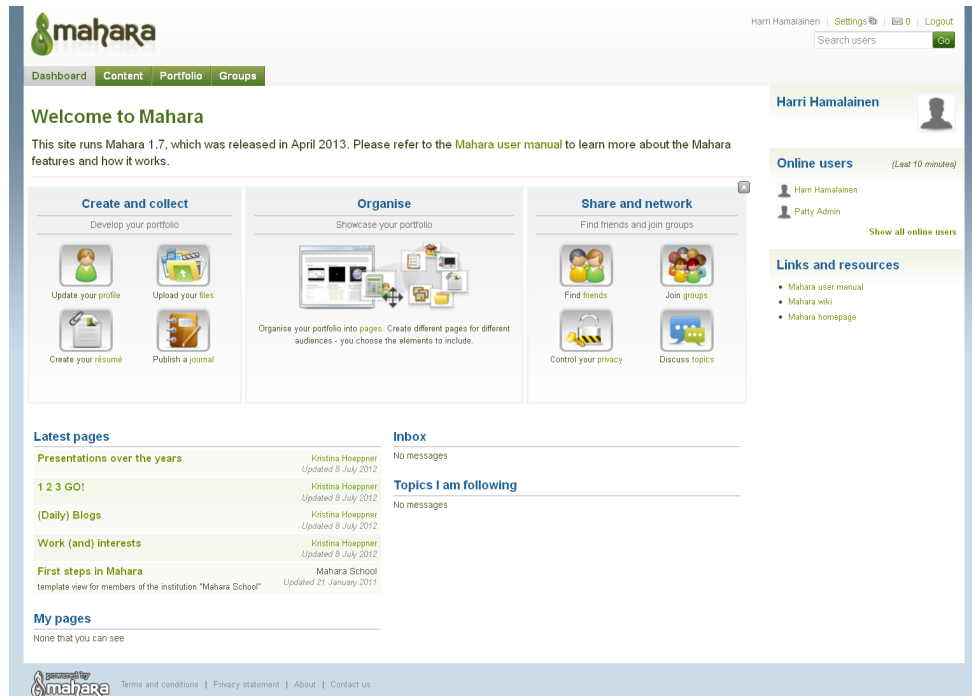


Figure 7: The front page of a learner's personal e-portfolio in Mahara.

The most obvious of the features to have been given little attention is planning. Although there is a tool that users can use to create personal plans that they can embed as a part of their views, the single tags in these plans are simple, the plans cannot be merged with each other, and the synchronization of tasks with external calendars is not possible.

2.4 Integrating the e-portfolio into university services

Although the digitalization of portfolios has given rise to new possibilities for the use of e-portfolios in different professions, it has also created challenges for portfolio management. Miles Kimball [Kim05] has researched trends that have had an effect on e-portfolio systems using electronic databases. He concluded that the relationship between existing e-portfolio systems and the traditional portfolio pedagogy is weak. E-portfolio solutions should not merely act as data depositories, but rather should support a learner-centric and organized collection of artifacts [Epc03], [Kim10a], [Lor05], [Sie04]. Therefore, the changes to the platforms need to be implemented sooner or later.

The importance of integrating the e-portfolio into teaching, study guidance, administrative processes and curricula has been addressed in previous studies. According to experiences reported by Wade and Yarbrough [Wad96] of the utilization of portfolios, students did not have any idea how to create a portfolio. This was due to the lack of experience they had with the instrument and also because the coursework that they accomplished was not associated with working on portfolios. This early result

of the utilization of the portfolio in practice emphasizes the challenge that is still recognized and needs to be overcome: integrating the construction of a portfolio with teaching and study guidance. Thus, close attention should be paid to the phase of presenting and explaining the purposes of portfolios.

Another consideration is the effect of e-portfolios on personnel, if they are also integrated into university services. Although portfolios are often advertised as innovative educational practices, the introduction of portfolios in everyday education often leads to disappointment [Tar07]. This seems to be due to the change of routines in teaching. Since the adaptation to using e-portfolios at the educational level also requires commitment and support technically and pedagogically, frustration against the e-portfolio solution easily crops up [Cha10b]. This raises a question: How should the integration of e-portfolios be carried out in university study guidance and teaching? Introducing the solution and all of the pedagogical changes at once will lead to resistance and a weak result. Therefore, the introduction of the e-portfolio in this context should be carefully considered.

Siemens [Sie04] has meritoriously categorized the introduction of e-portfolios into five levels, which are presented in Figure 8. In the simplest case, the portfolios are constructed through a simple content management system which acts only as a data depository. It may allow file sharing, etc., but the educational and developmental aspects are mostly not taken into account. In the second level, more sophisticated technical solutions and functionalities have been included in the platform, such as dynamism of the information and the possibility to create different views or representations of the collected information. In the next two levels, the role of the institution has been taken into account as a service provider and as an actor supporting the process and integrating instruction and teaching into the process. At the highest level, interoperability and thus the aspect of lifelong learning are taken into account.

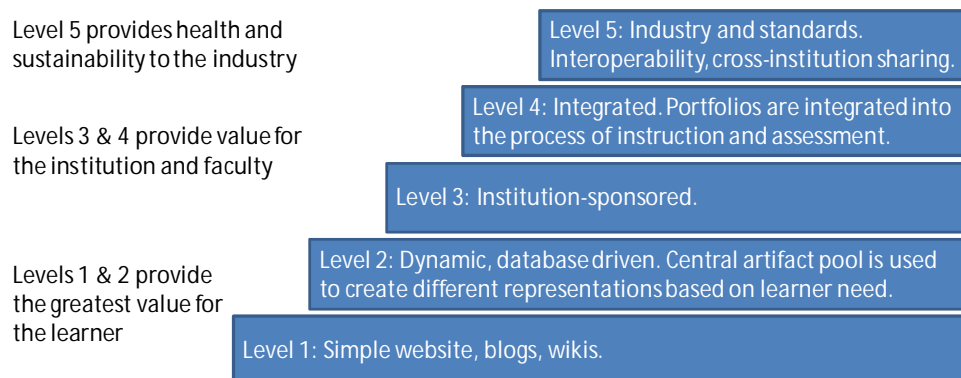


Figure 8: The stages of e-portfolio introduction by organization level, according to Siemens [Sie04].

With regard to choice of e-portfolio platforms and to the comparison of the existing top-quality solutions covering the organization levels presented in Figure 8, an important conclusion can be drawn. The adoption of the e-portfolio is only partly about the technology and the platform being used; the institutional commitment also plays an important role. Platforms similar to Mahara can provide features from the second up to the highest level of adaptation. Technological challenges and features are again to be considered at the highest level in the form of interoperability, but the level of deployment is still considerably based on the integration of the process at the

institutional and faculty levels. To support the process, universities need to take part in the process and tutor the students at a high level, yet leave the students in control. The representation of the information being created and collected is a visible outcome for the students and is typically one of the starting points when the purpose of e-portfolios is explained to students. The previously listed applications and the experiences of deploying e-portfolios have led not only to the improvement and development of the construction process of personal e-portfolios but also to lifelong learning. Students use all types of applications provided by different suppliers to create the artifacts to complete course requirements and to prove their abilities. Therefore, the platform used to collect and present this information must provide sufficient capabilities either for integrating this information directly into the personal portfolio or for linking to and describing the information in the portfolio.

In a comparison of the categorization made by Siemens to the applications for the different steps of constructing the e-portfolios, connections can be found. At the lowest levels, the organization provides individual tools for courses and development, such as learning management systems, to complete the assignments. As reaching level four requires that portfolios be integrated into the process of instruction and assessment, planning and representation also must be taken into account in portfolios. Because at level five the standards, industry, interoperability, and cross-institution sharing have to be taken into consideration, transition to the world of work is better covered.

Personal development is a lifelong process, and it too reflects the technological requirements of e-portfolios. The commitment of universities to supporting lifelong learning through the transferability of e-portfolios is an important topic when considered from the technological perspective, which sparks questions. For instance, if students are using a closed-to-the-public system provided by the university to manage their portfolios, is access to this system going to be removed after graduation? Using hosted services may also involve a risk: What is the interest of a commercial enterprise in providing an opportunity to export the portfolio at the time of graduation, when the university will likely stop paying for its use? These enterprises would most probably like to keep these graduates as their customers and charge them for the use of their e-portfolio platform. If an employer later provides an e-portfolio or more likely a competence management system for their employees, what is their interest in providing the service for the ones who have changed employers? If e-portfolios are going to be used for a lifetime, as promoted, there has to be the means for transferring them from one system to another without losing valuable information. Therefore, interoperability standards and specifications play a pivotal role and need to be taken into account when making university-level decisions on the selection of systems.

2.5 E-portfolio experiences

Portfolios became an increasingly popular method for assessment during the 1990s [Ewe02], [Kni06]. When e-portfolio solutions are being selected for students, it should be considered whether or not assessment of the portfolios is included. If it is, the next question is if it has an effect on the students' full control over their portfolios and thus on learner-centricity. Moores and Parks [Moo10] have listed a dozen tips for introducing e-portfolios to undergraduate students. Although the list was originally prepared for health care students, most of the tips also apply to engineering students. They start with the identification of the added value that portfolios can contribute and highlight the importance of reflection and its potential for learning.

Chatham-Carpenter et al. [Cha10a] have investigated findings of current practices in e-portfolio use in a survey of 43 higher education institutions delivered in the spring of 2009. They conclude that it is important to make clear the purpose of the solution for each party. Since the possibilities of use are manifold, it should be considered whether the solution is to be used to enhance learning, to conduct an authentic program or institutional assessment, to support students as they prepare for future careers, or to meet certification standards.

The number of stakeholders is also one of the reasons why the implementation of e-portfolios is complex [Joy09]. In general, in order to make a reasonable adaptation to using e-portfolios and to make purposeful use possible, all the stakeholders – the students, faculty, and institution – have to be involved in determining what the needs are.

2.6 Discussion

Although a wide variety of definitions exist for potential approaches to managing e-portfolios, the author of this thesis has taken an approach in which the e-portfolio platform is seen as a learner-centric, web-based service provided by an institution. The features of traditional portfolios should be taken into account in implementation but also be augmented by the special characteristics that the electronic approach provides. The users must be provided full control over administering their information, and if some assessment through the platform is to be done, there has to be the means to do it on the learners' terms.

Since this thesis is related to the implementation of standalone web-based applications that can be used to create information to support the construction of e-portfolios, the e-portfolio platform also plays an essential role in showing how these applications can technically be put together. The applicability of e-portfolio platforms was evaluated with the following criteria:

- *Open source.* The platform has to be provided as an open source to guarantee the possibility of further development to meet the needs of interoperability and full access to the included information and operations.
- *The development work of the application has to be managed by a credible community.* The development of e-portfolio platforms is still in its infancy. Current systems will require plenty of changes to provide essential functions in the future. Essential updates, such as security fixes, must be available when needed.
- *Essential portfolio features have to be supported.* One of the major challenges of the e-portfolio platform implementation is that the construction process has been considered poorly. The planning function, if even supported, is disconnected from other content, and the calendar and skills are presented as lists rather than as objects. Reflection is scarcely mentioned. If no features to support the portfolio cycle are provided, development in the process made only on the part of students is unlikely to happen.
- *Usability has to be good.* No matter how extensive the system is, if usability is weak, users will not use the tool voluntarily.

Three open source platforms that can be considered as e-portfolio tools were evaluated based on these criteria. The conclusion of evaluation results are presented in Table 3, showing that both Mahara and Elgg performed better than the third application, ePET.

Table 3: The evaluation criteria of the platforms for the needs of this thesis.

<i>Platform</i>	<i>Open source</i>	<i>Community</i>	<i>Features</i>	<i>Usability</i>
Mahara	+++	++	++	+
ePET	+/-	+	+	++
Elgg	+++	++	+	++

Based on the requirements, earlier studies presented in chapter 2.3.1, and personal experiences regarding the platforms, Mahara was selected for this study as a reference and piloting platform. Mahara has satisfactory functionality in fulfilling even more challenging requirements than what successful adaptation to the process would demand. The implemented applications need to be provided an interface through which the information may be transferred to the platform if the outcomes are also to be user-friendly (meaning that they allow for concrete artifacts and evidence of achievements). Therefore, the fact that Mahara is distributed in an open source manner meets the author's requirements. The implementation of these interfaces is at least theoretically possible, but depends on the resources available.

3 Recognizing skills – the basis for personal development planning

Occupations are commonly not necessarily clearly defined, and at the same time, individuals have increasing educational requirements [Onn03]. People are expected to master several occupations simultaneously in order to be successful in their careers. Hard, often technical skills have traditionally been used to describe the strengths and competencies of a single individual, especially in the ICT industry. This often also reflects the teaching of engineering in universities: when course contents are described in study guides, the naming of hard skills is mostly used to identify the learning outcomes from the courses, since those form the basis of students' professional development.

Students often have a rather generic idea of their dream jobs when they make plans for their education and set goals for their careers. They might look forward to being programmers, consultants, project managers, or something else, but they do not necessarily know which types of technical and non-technical skills are demanded for these jobs. In the case of a programmer, they might assume that what is required is the knowledge of a specific programming language, but they do not necessarily know that methodological and interpersonal skills, such as good team-work abilities, may be required.

When considering jobs with less emphasis on technological tasks, the importance of soft skills becomes even higher. For example, interpersonal skills play an important role among ICT professionals who regularly interact with colleagues and customers. These skills are personal attributes and behavioral competencies that reflect one's personality and ability to interact with others. Also, the higher the job level is and the more responsibility the position entails, the more appreciated the soft skills are. These skills are not necessarily taught, appreciated enough, or even self-evaluated during studies and personal development, since they are challenging to measure. However, they are indeed important for the development of professional competence. Mainstream technologies change over time, sometimes rapidly, but soft skills are necessary throughout one's entire career.

There are numerous different categorizations for the ICT field alone. For example, Aken et al. [Ake07] have presented a skill categorization in which soft skills, non-technical hard skills, and technical hard skills have each been divided into four subcategories. They have given a more detailed description of the skills in these groups by summarizing more than 80 skills in their categorization. Their categorization of skills is presented in Table 4.

Table 4: Categorization of skills into soft skills, non-technical hard skills, and technical hard skills, with examples based on [Ake07].

<i>Skills</i>	<i>Description</i>	<i>Detailed description</i>
Soft skills (23 skills)	Problem-solving skills	ability to learn, attention to details, business problem solving, creativity, critical thinking, general problem solving, research skills, working under pressure
	Interpersonal skills	conflict resolution, interpersonal relationships, leadership, self-esteem, teamwork
	Work Ethic	motivation to work, ethics, professional ethics, responsibility, self-management, time-management
	Language Skills	negotiation skills, oral communication, questioning skills, written communication
Non-technical hard skills (17 skills)	Business processes	accounting, business process engineering, contracting and legal issues, finance, marketing, SCM
	Management skills	change management, managing 3rd party providers, outsourcing management, user relationships management, working globally, working with virtual teams
	Project management	project management / planning / budgeting / scheduling, project risk management
	Strategy skills	business intelligence, business strategy, project integration
Technical hard skills (43 skills)	Software development	e.g. agile development, programming, communication paradigms, systems design, UI design
	Business application	e.g. applying IT to business problems, CRM, ERP, operating systems, transactions processing
	Information management	data mining, data warehousing, database admin, EDI (e-business)
	Hardware	IT architecture, network administration, security, voice/data communication

In terms of the skills that students learn and need, three parties play an essential role:

- **Industry**, by providing work for graduates, thus defining the requirements for the skills that they should have and thus be taught;
- **Academia** (university), by providing teaching to give the tools for students' development;

- **Students**, by being responsible for learning and mastering the skills that are taught.

Figure 9 presents the relationships between these parties based on the flow of skills. First of all, industry has a demand for professionals able to fulfill industry requirements by possessing important skills and having the potential to absorb the knowledge they need. Universities endeavor to take these requirements into account and provide students with a good foundation for adopting these skills. The teaching that universities provide for their students does not only serve the needs of industry; academic goals and requirements also must be considered. The education has to be extensive enough to cover many different types of expertise in a large variety of jobs. On the other hand, all the skills needed later on in the world of work can never be comprehensively covered by teaching. In the end, students themselves are responsible for learning and adopting a comprehensive set of skills and being able to show their skills and provide their know-how to employers.

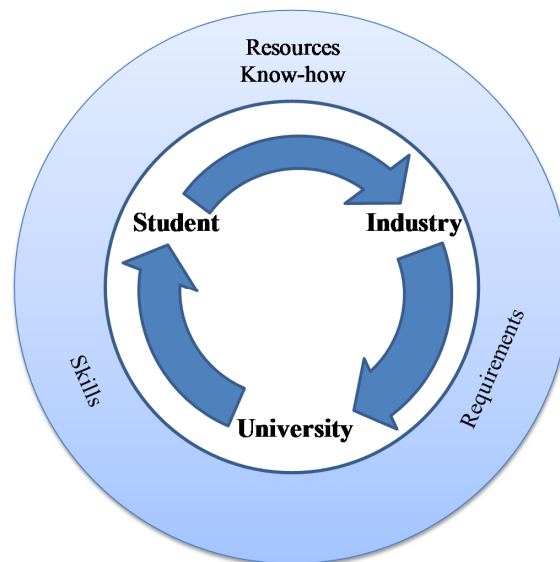


Figure 9: Relationships of the three parties.

However, it is obvious that the flow is not only one-directional. Similarly to the setting of requirements for teaching at a university, information about industry needs has to flow to students. Nevertheless, finding out about and being aware of these requirements in detail and comprehensively is often challenging. The information exists, but students do not necessarily take it into account or they are unable to create a whole picture of the requirements. For example, in recent years, Lappeenranta University of Technology has researched [Lap06], [Lap07], [Lap08], [Lap10b] the challenges that its graduates have faced by sending a questionnaire to alumni who had graduated five years prior to the time of the survey. One of the topics concerns the challenges of looking for a job. Although the questionnaire mostly yields answers pointing to the importance of soft skills, its results would be a valuable source for students. However, it seems that students are not familiar with the results. If they were, they would have a chance to use the information to support their personal development planning. A better awareness of requirements could result in students' understanding why topics are being taught with

certain methods and in turn increase students' motivation to learn, and the relationships between skills and requirements would become clearer.

This chapter cites examples of how existing information can better be taken into account and tied into the student learning process. A tool for collecting and indexing information about industry requirements in job advertisements is introduced to show how to transfer existing information for students. It can be used to reveal information about the requirements and particularly to provide students with a better picture of how extensive the requirements can be. Better awareness of the requirements can also lead to more focused learning, which can also be supported by the university by providing more detailed information about the learning outcomes in courses. Courses have earlier been classified in departmental level based on teaching methods, which relate to numerous soft skills, and the results are presented in *Publication 3*. Thus, more exact information about courses to students can be provided. Combining personal preferences that can better be determined using the implemented tools and providing more exact information about courses should offer students better possibilities for dividing their high-level career goals into smaller learning goals and for creating their personal study and development plans for their university career, which would also serve to support their personal preferences and strengths.

3.1 The role of soft skills as a part of teaching

Soft skills are not just learned during one's studies at the university, they are learned throughout life. These skills are developed to a great degree in everyday life through hobbies and experiences, thus having a clear relation to lifelong learning. Based on years of research, Goleman [Go95] has suggested that for job success, one's emotional intelligence matters twice as much as one's intelligence quotient (IQ) or technical skills. The economy today requires much more from graduates than only acting as sponges for information [Har10]. According to Fernandez-Sanz [Fer10], the higher the level of the job, the more soft skills are brought up in advertisements. This also concerns employees in the ICT sector.

Learning soft skills can partially be covered in university courses, but their importance is not that well recognized by learners or even by all teachers. At any rate, students do learn these skills in their studies and also in their everyday life. Recognizing these skills in teaching, communicating these skills to the students and respecting the value of acquiring experience in using these skills may often be challenging. These skills, their importance in industry and their inclusion in teaching at the Department of Information Technology at LUT are discussed next.

The use of soft skills is occasionally described in course descriptions or can likely be inferred based on the teaching methods used. Students may complete group work and in doing so obtain experience of the different roles in a group, complete peer assessment tasks, act as opponents to each other, or give presentations – sometimes in foreign languages instead of their mother tongue. Even if these skills are not directly mentioned in course descriptions and degree certificates, they are valuable capital and amount to important experience. Students may be able to prove their language skills by the diplomas and degrees they have received by passing courses, but the use of these skills on different occasions still provides even more valuable experience in many cases.

Fernandez-Sanz [Fer10] proposes that academic staff should also promote soft skills in the curriculum. Some examples of the skills he lists are customer orientation and results orientation. One of the challenges of soft skills in university education is that they are typically more difficult to recognize as a part of a course. Firstly, evaluating these skills from the teacher's point of view is more challenging than evaluating the more technical hard skills. Secondly, evaluating these skills is not necessarily appropriate, since the main objective often is to learn technical skills. Therefore, there are not many credible ways of demonstrating one's possession of these skills. As it is difficult to highlight these skills in applications, they are not taken into consideration until during the interview in the process of seeking a job [Hyv09].

Although soft skills are often also associated with emotional intelligence and may be perceived as inborn skills, they can also be practiced. Crosbie [Cro05] has suggested that whereas the learning of any skill takes time, the learning of complex personal and interpersonal skills (of leadership) takes even more time. On the other hand, the need for these skills is permanent and relates to a large number of jobs. When considering the complexity and demand for learning soft and interpersonal skills, one has to keep in mind their importance for employment and their continuous need that does not change as the requirements for technical skills change. Learning hard skills and technologies is necessary for IT students and employees, but in some cases these hard skills are used for a limited amount of time. In other words, when one gets a job, it might be extremely necessary to know a certain technology, but in a few years' time, this technology may be deemed obsolete and replaced by another, or the responsibilities at work may have changed so that mastering this technology has become unimportant. This does not mean that learning hard skills may be neglected – quite the contrary. Instead, this should emphasize the importance of soft skills: they will most likely be used and considered rather important throughout one's entire future career.

Table 5 sums up the results of previous IT students based on questionnaires sent to graduates from Lappeenranta University of Technology between the years 2006 and 2010 [Lap06], [Lap07], [Lap08], [Lap10b]. The importance of each skill is evaluated on a scale of 1 to 6, 6 being very important. The respondents had all graduated five years earlier at the time these questionnaires were completed, thus having some experience about the industry requirements concerning the skills evaluated. Table 5 also demonstrates how some notable gaps between the learning outcomes and requirements at work can be discovered.

Table 5: Skill demands at work compared to skill development during studies at the IT department.

	2006 (N=41)			2007 (N=59)			2008 (N=59)			2010 (N=45)			AVG (N=204)		
	Work	Uni	Diff	Work	Uni	Diff	Work	Uni	Diff	Work	Uni	Diff	Work	Uni	Diff
Negotiation skills	4.60	2.60	-2.00	4.40	2.60	-1.80	3.70	3.00	-0.70	5.30	2.50	-2.80	4.50	2.68	-1.83
Organizing- and coordination skills	4.50	2.90	-1.60	4.40	3.10	-1.30	4.40	3.20	-1.20	5.30	3.40	-1.90	4.65	3.15	-1.50
Problem solving skills	5.40	4.20	-1.20	5.40	4.20	-1.20	5.20	4.20	-1.00	5.70	3.30	-2.40	5.43	3.98	-1.45
Management skills	4.00	2.30	-1.70	3.70	2.10	-1.60	3.30	2.80	-0.50	3.50	2.00	-1.50	3.63	2.30	-1.33
Presentation skills	N/A	N/A	N/A	N/A	N/A	N/A	4.00	3.40	-0.60	5.30	3.30	-2.00	4.65	3.35	-1.30
Group work and social skills	5.20	3.90	-1.30	4.90	3.70	-1.20	4.80	4.00	-0.80	5.50	3.80	-1.70	5.10	3.85	-1.25
Teaching, education and guidance skills	N/A	N/A	N/A	N/A	N/A	N/A	3.60	3.10	-0.50	4.20	2.50	-1.70	3.90	2.80	-1.10
Project management skills	4.60	3.50	-1.10	4.10	3.40	-0.70	3.70	2.90	-0.80	4.80	3.60	-1.20	4.30	3.35	-0.95
Finnish language skills	4.30	3.80	-0.50	4.40	3.50	-0.90	4.30	3.90	-0.40	5.70	3.80	-1.90	4.68	3.75	-0.93
English language skills	5.30	4.20	-1.10	5.10	3.90	-1.20	4.70	4.30	-0.40	4.80	3.80	-1.00	4.98	4.05	-0.93
Analytic systematical thinking skills	5.30	4.70	-0.60	5.30	4.30	-1.00	5.10	4.70	-0.40	5.80	4.20	-1.60	5.38	4.48	-0.90
Financial planning and budgeting	3.10	2.50	-0.60	2.80	2.40	-0.40	3.10	2.40	-0.70	3.70	2.00	-1.70	3.18	2.33	-0.85
Information retrieval skills	5.40	4.60	-0.80	5.40	4.30	-1.10	4.80	4.60	-0.20	5.00	4.50	-0.50	5.15	4.50	-0.65
Information- and communication skills	5.00	4.40	-0.60	4.90	4.20	-0.70	4.50	4.60	0.10	5.20	4.20	-1.00	4.90	4.35	-0.55
Knowledge of legislation	2.70	2.00	-0.70	2.90	2.10	-0.80	2.90	2.50	-0.40	4.30	4.20	-0.10	3.20	2.70	-0.50
Theoretical knowledge of the study field	4.30	4.30	0.00	4.90	4.50	-0.40	4.50	4.60	0.10	4.80	4.20	-0.60	4.63	4.40	-0.23
Knowledge of basics of entrepreneurship	2.80	3.00	0.20	2.90	2.60	-0.30	2.90	3.00	0.10	3.30	2.60	-0.70	2.98	2.80	-0.18
Swedish language skills	1.60	2.80	1.20	1.40	2.80	1.40	2.20	2.60	0.40	2.20	3.70	1.50	1.85	2.98	1.13
Other language skills	1.60	2.30	0.70	2.60	2.60	0.00	1.60	2.40	0.80	1.00	4.00	3.00	1.70	2.83	1.13

Based on the summary, the interviewees felt in particular that negotiation skills are paid very little attention to in teaching, whereas these skills are considered quite important at work. Management skills show same type of trend, but the gap and especially the demand in world of work are smaller. One also has to bear in mind that not all the skills are essential or sometimes even possible to teach within the frames of curricula and that these two skills are not necessarily demanded of workers in the beginning of careers. Other skills with notable gaps include organizing and coordination skills, problem solving skills, presentation skills, and group work and social skills. However, they are clearly being paid more attention to in teaching than the first two, being skills that are often more important in entry-level positions.

Crosbie's findings [Cro05] regarding the most important skills demanded by industry confirm that soft skills are not necessarily present in the repository of educational resources. In order to be able to analyze the strengths and weaknesses in the department's teaching and the outcomes of courses, information is needed concerning the teaching methods and personal skills that are involved in each particular course in the Department of Information Technology at LUT. The results were published in *Publication 3*, and a summary is presented in Table 6. The findings are divided into two main categories: teaching methods and personal skills. Teaching methods are further divided into contact teaching and supporting methods. Personal skills are divided into skills and knowledge and social skills. For each course, skills are awarded from zero to three stars to identify the importance of the teaching method or skills used in the course. Each skill and teaching method has been given requirements for each number of stars. The plus sign (+) is used to mark aspects which do not clearly qualify for a higher number of stars, but are clearly more important than the lower number of stars. When calculating the total value, the plus sign is given a value 0.5. Parentheses are used if the course has some aspect which is not completed by all students, e.g. due to a choice of assignment. It is also given a value of 0.5 in the calculations.

Table 6: Summary of teaching methods and skills reproduced from *Publication 3*.

Course	Contact teaching					Support methods					Personal skills and knowledge										Social skills						
	Lectures	Demonstrations	Seminars	Exercises	Practical work	Quizzes	Real world cases	Virtual / online	Home work	Home exercises	Home examination	Essay / review	Critical thinking	Problem solving	Written presentations	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 prog.	**		*				*	**	**			**	**	*				(+)	***	*	*		(+)				
Group work course on comm.	*	*	***					***				*	**	**	**	*	*	***	***	**	**	***	***	***	***	*	*
Content production	*	**					**	***	*		*	**	**+	**	**	**	*	***	*	*	+	**	**(*)	*	**+		

Total	72	4	11	51	13	6	2	12	40	41	11	3	40	54	29	15	17	38	23	29	42	35	15	11	15	21	2

When one examines the different personal skills, it can be noticed that problem solving skills are clearly well-represented as a part of teaching. Project work, presentations and particularly evaluation skills are not being paid significant attention. On the other hand, even less attention is accorded to most of the social skills. Negotiation, interaction and leadership skills are not well represented, and supervision skills are not dealt with at all. However, as the earlier results show, these skills are important. All skills, especially learning skills that require more experience, cannot be covered by university teaching. However, they may still be taken into consideration while the curricula and course methods are being planned.

The first step towards meeting the needs for soft skills in teaching has been taken by the analyzing more deeply the outcomes of and methods used in the courses. Providing just some additional information about the soft skills being taught in courses does not necessarily provide any added value for the student, but it does give us a tool to evaluate the soft skills involved in teaching. However, when there is a chance to demonstrate which types of jobs these soft skills are related to, the information becomes more important and engrossing from the student perspective.

3.2 Skill requirements from the industry perspective

Students do not necessarily consider the importance of wide variety of skills learned during their education as much as they do that of the degree. As educational institutes aim to offer courses that create sufficient know-how and a basis for learning and adapting to technologies, students still experience difficulties in dividing these requirements into more specific skills. In addition, the relations between different skills are not necessarily obvious. However, the skills do play an essential role in finding employment.

Even if the importance of soft skills has increased of late, hard skills typically play a more important role than soft skills in the earliest phases of the process when employers select candidates based on their CVs and job applications [Hyv09]. In any case, representing hard skills by means of certificates or examples is normally easier in this phase. Soft skills are assessed later during the interview and possible psychological

tests. Fallows and Steven [Fal00] have listed a number of employability skills which include the retrieval and handling of information, communication and presentation, planning and problem solving, and social development and interaction. These skills can be classified as soft or non-technical skills based on the categorization presented by Hitchcock [Hit07].

3.2.1 Methods of collecting skill requirements

Research into industry requirements for skills has traditionally been completed by interviewing different industry representatives or by manually investigating job advertisements from newspapers or professional magazines [Sur05]. The problem of these methods is that they require a considerable amount of time and resources. The Internet era has for its part changed the way companies search for employees from the market: while web-based services have gained popularity, the number of advertisements in newspapers has decreased, and the content of advertisements has also changed. Formerly, advertisements were concise due to the limited space and the expenses, and soft skills did not typically receive that much attention.

Another challenge of the manual investigation of advertisements is the growing number of existing technical skills. Once the advertisement is handled, re-analysis in the case of a new list of skills causes the work to need to be completely redone. On the other hand, the quality of manual analysis by skilled persons is presumably more reliable and adaptive than computer analysis.

3.2.2 Job advertisements as a source of hard and soft skills in demand in the ICT sector

The content of job advertisements (also in the case of the ICT sector) has been analyzed over the past decades. The research and analysis on the content in advertisements are typically completed for the U.S. job market. The results are likely to represent the global circumstances, employment situation, and requirements well. However, there are presumably some regional, national, and culture-based divergences between the positions and requirements. These differences are supposedly even more emphasized considering the required soft skills.

According to numerous studies, the mean of listed skills per advertisement has been rising since the 1970s. For example, Todd et al. [Tod95] have reported that the number of technical phrases in job advertisements for programmer positions has increased from a mean of 2.2 in 1970 to 4.2 in 1990. The trend has continued to rise ever since. Based on the survey conducted by Surakka [Sur05], the number of desired technical skills has also been increasing since the 1990s; the number of technical skills per advertisement has increased from a mean of 3.57 in 1990 to 7.66 in 2004. However, the numbers are hard to compare since the skill sets used for these studies have not been published. All the skills have not necessarily been included in the earlier studies, and they may also have significantly changed over the years. Thus, the comparison of individual studies of different research groups is difficult.

In addition to the increased number of demanded hard skills, the number of listed soft skills has been increasing. Numerous studies, such as those by Lee et al. [Lee95], Lethbridge [Let00], and Wade and Parent [Wad02], have revealed the importance of non-technical (soft) skills in addition to technical skills. This relates not only to the

advertisements, but also to the role and inspection of soft skills as a part of the recruitment process, seemingly having become more important than earlier. Therefore, the ability to become aware of, to analyze, and even to demonstrate personal soft skills is advantageous for a job seeker.

Since web-based services have become such an important source of job advertisements, it is reasonable to use these services as sources for analyzing the advertisements. A sample of a job advertisement and the terms identified is presented in Figure 10. Since advertisements typically list sets of skills, gathering and analyzing the skills and their potential relationships to each other might help students even before they are seeking employment. In addition, this information can be used to demonstrate how extensively the content of courses and teaching meet the requirements of industry.

<p>Job Summary</p> <p>Company ImaginarycompanyLtd</p> <p>Location Lappeenranta/Finland</p> <p>Industry Compute/IT Service</p> <p>Job Type Full Time Permanent</p> <p>Years of Experience 2+ years</p> <p>Salary 3.500,00 per month + benefits</p> <p>Job Reference Code 3049334</p> <p>Contact Information Brian Kottarainen ImaginarycompanyLtd Phone: 555-3223, 555-7334</p>	<p>Web Developer (PHP) Lappeenranta</p> <p>About the Job</p> <p>Web Developer, Lappeenranta/Finland (PHP, MySQL, Javascript, HTML, XHTML, CSS, XML, Ajax, Apache, Drupal)</p> <p>The Imaginarycompany Ltd is currently working in hand with a Finnish Ministry of Education. The client is looking for a Web Developer due to recent organic growth.</p> <p>You will be an experienced web developer with at least 4 years experience of developing with PHP, MySQL, and LAMP platform in general. You will have very strong skills in web development as you will be required build and implement business orientated systems connecting directly to the company's databases and applications. You will be expected pick up work on existing Drupal sites as well as the development and delivery of brand new systems and applications.</p> <p>The client has a preference for candidates that have a university education background, preferably M.Sc. from Computer Science or Industrial Engineering, although this is not essential. The most important factor will be that you are an innovative and passionate developer who can bring new ideas to the table. You will be enthusiastic and keen to find efficient solutions that effectively meet business requirements. You will have a free reign to use the technologies that you feel will be most suitable. You will be looking for a challenge and will be eager to progress and commit yourself to one organization long term.</p> <p>This role is commutable from Pajar, Taavetti, Monni, Rapasalo, Parkkilahti and Kisapuisto. The client is well connected to major public transport routes.</p>
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Figure 10: An example of a job advertisement.

Using computers and algorithms to interpret the content analysis is generally considered to be challenging. Litecky et al. [Lit10] have published several studies on skill set mining from job advertisements. Nelson et al. have developed a parsing application [Nel07] to retrieve and extract terms from job advertisements; this was also used in Litecky's research. By automating this inspection and using their tool, they have been able to extract and analyze more than 200 000 job advertisements requiring a degree in computing science. The terms that they were searching for included various technical, programming, business, and soft skills, and the final collection of skills included 239 terms and synonyms based on prior research. First, they eliminated the advertisements that included too few or too many skills, and then the skills that appeared in fewer than two percent of the remaining jobs were excluded. In the end, 69 skills remained for their analysis. Based on the results of their research, they were able to list the most frequently mentioned skills in computing job advertisements, delineate the major skills classified by job title, and show the distribution of job advertisements by job type.

According to an interview with Hyvärinen conducted by the author of this thesis [Hyv09], there are not necessarily significant associations between the skills and terms in advertisements and work requirements so as to be able to make generic assumptions. Different sizes of companies may have different types of needs. Smaller companies need employees with wide-ranging skills who are capable of doing many types of work, whereas larger companies might be looking for specialists of a narrower area.

Therefore, defining a detailed and comprehensive skill set covering all types of ICT jobs is impossible, but valuable support can still be provided.

3.3 Identifying skill requirements in Finnish ICT job advertisements

Information concerning technology trends and primary hard skills in the labor market is not overly difficult to find and is presumably available via existing tools and services such as Google Trends¹³. However, it is more challenging to determine which types of skills are related to which types of job titles, and which secondary hard and soft skills related to the technical primary skills can be found. By analyzing the Finnish ICT job advertisements, the skills usually required for different positions can be better determined, and the current situation and development of the labor market can be better assessed.

3.3.1 Implementing *JobSkillSearcher*

Since job advertisements in the ICT sector are available from various Internet-based services, a web-based tool called *JobSkillSearcher* was implemented to facilitate the gathering of advertisements and map the skills required in them. The core architecture of the application is presented in Figure 11. *JobSkillSearcher* collects job advertisements daily from various Finnish employment sites. The advertisements are automatically parsed and the skills and terms that are recognized are analyzed and classified into the database. After the advertisements are retrieved into the system, their contents are automatically analyzed. The system database contains a list of terms to be matched to sort out the advertisements. The users are provided a web-based user interface for searching for the requirements. The application is presented in *Publication 2*.

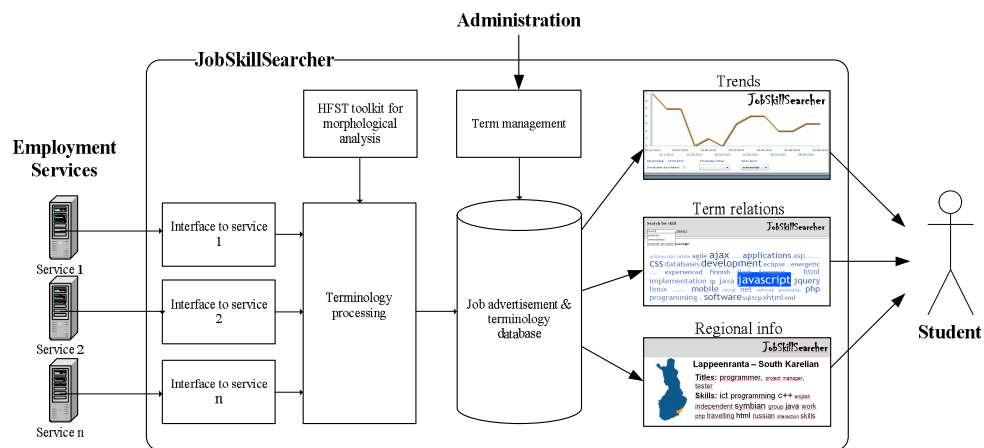


Figure 11: Architecture of *JobSkillSearcher*.

Indexing terms

The indexing of the terms was commenced by designing a structure for classifying the terms. The terms were indexed and divided into classes based on their type, and the

¹³ <http://www.google.com/trends/>

classes were later used to separate out the information. The primary purpose is to be able to present results in a more structural form; queries to the database can be performed using any term. A simplified model of the hierarchical structure including a few terms and arranged by categories is presented in Figure 12.

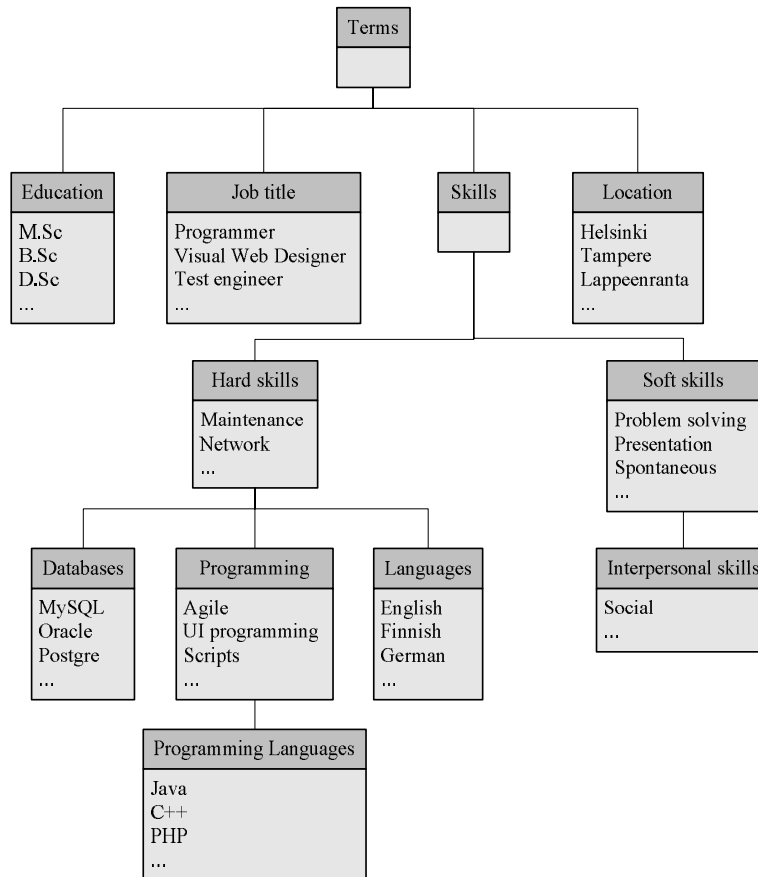


Figure 12: A partial model of the structure for indexing terms.

The next step in setting up the application was adding known terms within the created hierarchical structure to the database. Numerous hard and soft skills, names of programming languages, ICT companies in Finland, Finnish municipalities and foreign languages were added manually and imported from existing listings. Also, in the beginning of the lifecycle, the searches that had been completed with the tool were used to extend the terminology. This created a solid basis for the terminology, but extending the vocabulary and making it more comprehensive required other actions as well.

Skills in general, but especially closely related skills, appear in bursts in the advertisements. After a moderate amount of advertisements in the database had been collected, the terms already recognized were used to find the terms that most frequently appear in their vicinity. Also, the frequency of words was used both to find appropriate terms and, on the other hand, to exclude common terms that are not important for indexing the requirements.

Other issues arising in the analysis of Finnish text concern grammatical cases and declension. Identifying only the basic forms of skills does not provide a general view of the frequency of each term. Therefore, recognition and linking the terms with each other is needed. The basic forms of terms are morphologically analyzed using the Helsinki Finite-State Transducer (HFST) introduced by Lindén et al. [Lin09]. The module is integrated into *JobSkillSearcher* and is used to find the basic forms for each term and to link these with each other.

One of the challenges is the diversity of information: a considerable number of the terms recognized have only a couple of exact occurrences in the advertisements. However, the rarely appearing terms are not discarded, since they are often synonymous with popular terms and their number eventually becomes meaningful. This challenge mostly occurs with soft skills; terms for technical skills, such as “C# programming language” are unambiguous, whereas the Finnish term referring to “taking initiative” is not. The occurrences of different declensions of this term in the database are presented in Table 7. As it can be seen from the basic forms for these terms, morphological analysis only does not guarantee linking of all the terms with each other, and recognizing declined terms can be much more frequent and important than recognizing only the basic form.

Table 7: Occurrences of different declensions for the term "oma-aloitteisuus" (takes initiative) in the advertisements.

Word	Occurrences	Basic form
oma-aloitteisuutta	1 402	oma-aloitteisuus
oma-aloitteinen	1 139	oma-aloitteinen
oma-aloitteista	620	oma-aloitteinen
oma-aloitteisesti	259	oma-aloitteinen
oma-aloitteisuus	136	oma-aloitteisuus
oma-aloitteellisuutta	112	oma-aloitteellisuus
oma-aloitteiseen	48	oma-aloitteinen
oma-aloitteisia	25	oma-aloitteinen
oma-aloitteisen	19	oma-aloitteinen
oma-aloitteellisen	6	oma-aloitteellinen
oma-aloitteisena	6	oma-aloitteinen
oma-aloitteellisuus	5	oma-aloitteellisuus
oma-aloitteelliseen	2	oma-aloitteellinen
oma-aloitteisuuden	2	oma-aloitteisuus

Even if the basic form for the Finnish terms can be discovered using morphological analysis, there is still a need to link words with each other. The noun for ability (“*oma-aloitteisuus*”) and the adjective for characteristics (“*oma-aloitteinen*”) are still in different forms, but in the context of job advertisements, both represent the same requirement. This is also true for synonyms that can be combined with the requirement (“*aloitteellisuus*”, etc.). Therefore, the connections between the terms had to be created by forming a thesaurus for the terminology used to represent the requirements in IT job advertisements.

With its current term list and usage of morphological analysis to address the challenges of the declension of terms, the application is able to recognize most of the terms when new advertisements are added. However, not all meaningful or emerging terms can be recognized. Therefore, the content of the database occasionally has to be manually maintained. Different approaches have been considered, and the help of the users is one such. The searches users complete have revealed some new terms that are not necessarily identified by the system. Another approach is to have users go through and mark the content that has been collected. However, in this case, the challenge is how to motivate users to spend time reading through a list of terms and identifying potential ones. Forcing them to do so every now and then in between queries is likely to annoy them and make them either stop using the application altogether or just to be careless in their evaluation. This can be remedied. For example, a gaming approach to motivate volunteer users has successfully been used for different purposes, such as digitizing the content of old Helsingin Sanomat newspapers [Hel11] or tagging the content of images on the web [Goo11] by Google.

Indexing advertisements for job types based on the job title has also proven to be difficult. The database contains terms used to identify the job title mainly based on research completed by the Federation of the Finnish Information Industries [Tie09]. Even if the list is constantly being used and extended, and the job titles are distinguished in advertisements, categorizing them is often challenging, since advertisers frequently use free-form and informal terms, which are often misleading, according to Litecky et al. [Lit10]. They have instead used skill sets to determine the job types.

Representing and taking advantage of the collected information

After the required preparation for the system was completed, the next questions were how the users could be given the possibility to access the information, what should be provided, and how it should be represented in a meaningful way. The first and simplest step was to provide the students with the possibility to show a trend of a searched term or set of terms in job advertisements within a selected interval of time. A sample of this type of representation for the term “java” is given in Figure 13 This is a more useful feature when users are more conscious about the deeper requirements and know what they are looking for.

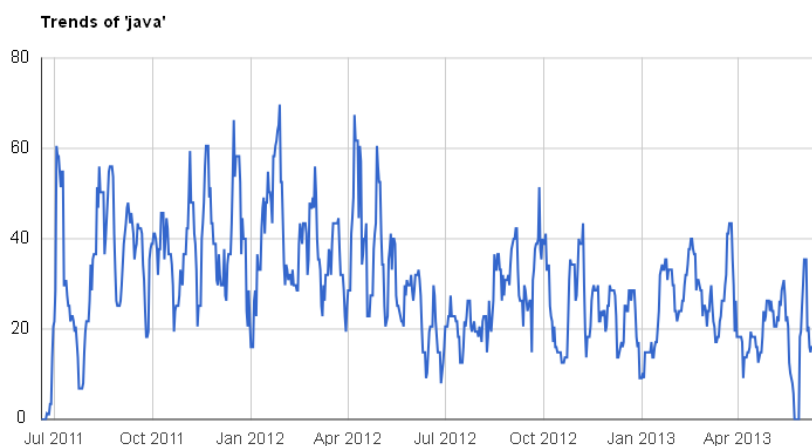


Figure 13: Representing the trend for the term “java” in a line chart.

However, ascertaining trends of terms or skills is not the primary objective of the tool. Instead, the aim is another type of result based on the terms which appear in association with the searched term. This is more useful when students are not fully aware of which other types of skills are typically requested in association with the skill in question. This type of query can also be used to find out about the type of job where the skill is typically needed. Typically, technical jobs require primary skills – such as programming using a certain language – but they also require secondary supportive skills that could be considered more useful and are requested more frequently than others.

Since the terms are all classified into groups, too, the search parameters can additionally be formulated based on the classification of the terms. Chatti et al. [Cha09] have used graphs for visualizing social networks in their interactive learning service of community mining. This can help the user to get a better picture of the general skills that are often mentioned, if some relative terms that appear often enough can be found. The JavaScript-based graph created using a self-customized version of Kyle Scholtz's Wordnet [Sch06] is used in *JobSkillSearcher* to present the search results. The user interface showing the search results for the term “*programming*” is presented in Figure 14. Although the vocabulary of the application has been mainly built using Finnish terms, some English terms are also recognized, and the names of tools and technologies are language-independent. The most frequent terms in each category in the advertisements matching the search are visualized. Users are able to see the title and description of these groups, as demonstrated with the group “*Education*” and can make new searches either manually or by clicking the appearing terms.

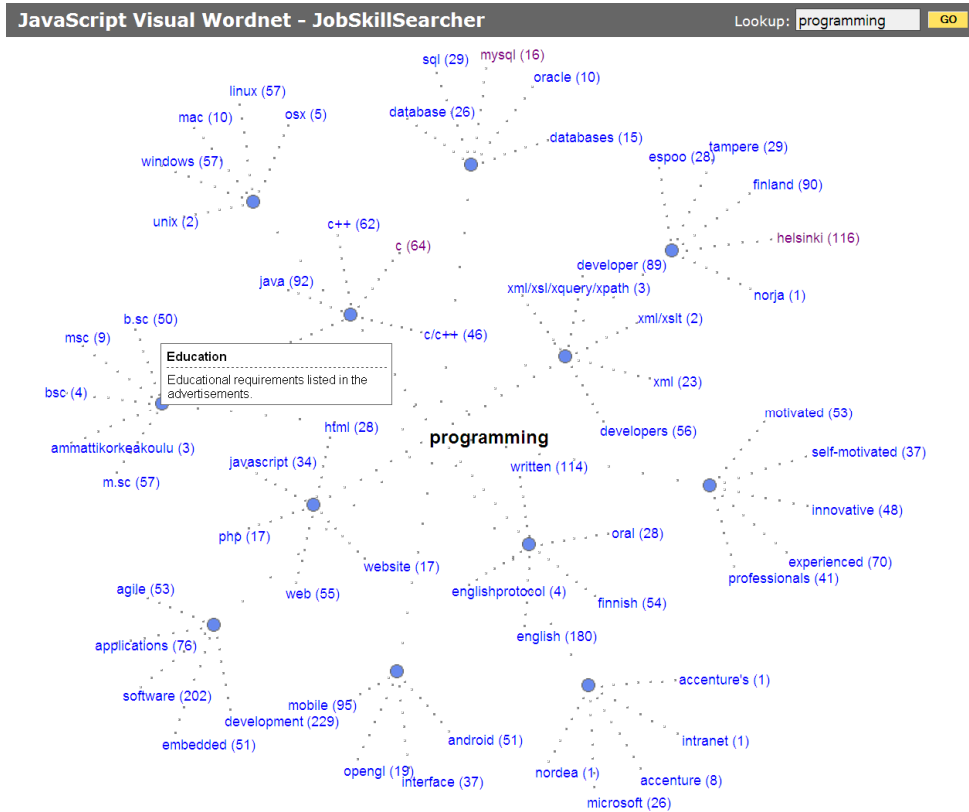


Figure 14: The most relevant terms related to the term “programming” and classified by term types.

The tool can also be used to analyze skills in advertisements based on other variables, such as geographical location, job title or company name. One can study whether some skills are more important than others regionally (indicating the type of local ICT industry), whether soft skill requirements between different companies vary (different sets of values and interpersonal skills, completely different types of jobs in extent) or which types of skills different job titles typically require (to provide help for personal development planning). However, this information would probably be more valuable for research purposes, not for the students who are gaining an awareness of the skills that they should take into account while planning their development.

Evaluation

The current system has been collecting advertisements since March of 2011. As a result, there are more than 14 000 Finnish ICT job advertisements in the database consisting of over 2 300 000 words. Presently the application is able to identify more than 9 000 terms, including synonyms and recognized declined forms, all classified by term type. On average, more than 15.7 meaningful terms (on average 4.9 terms categorized as soft skills and 7.5 as hard skills) per advertisement are recognized, which should be considered as an appropriate starting point for being able to provide valuable information to students, rather than being only for research purposes. The results collected thus far are difficult to compare to the results of previous research in view of

the number of skills required, since we do not have access to the skill sets used in other research.

The ability to automatically find certain skills among advertisements has been evaluated with three tests. The application has been evaluated by comparing how well it was able to identify the terms compared to manual identification. For the first test, three experienced persons with a strong ICT background analyzed the advertisements, and each of them processed 12 random advertisements (each person having three of the exact same advertisements) from the system. Instead of giving a set of skills to be recognized from the advertisements, the test persons were asked to identify any terms that they would relate to skills or requirements. This caused considerable differences in the results, even among the results regarding the exact same advertisements. The person who recognized the highest amount of skills from the advertisements found over twice as many as the person who identified the least amount of terms had found, whereas the third person placed in between the other two. Eventually the test was deemed as useless for evaluation purposes, but the results were used to discover some weaknesses the system had and subsequently to improve it.

The second test was run in two phases with five graduates, three of them having more than ten years of experience after graduation and two of them in the beginning of their careers. Based on the experiences learned from the first test, the instructions were re-written, categorization for different skills was provided, skills were explained and a sample of how to mark the detected terms was given. In the first phase, the participants were all given same ten random advertisements for analysis to find out the need for calibration. The results were collected and stored in a database for evaluating and examining the results. The average amount of skills (expressed either in single terms or sentences) per person varied from 14 to 22 per advertisement. Krippendorff's alpha test was run to find a coefficient of internal consistency of the results. The calculated reliability ($\alpha = 0.491$) indicated that a more detailed examination of the results was needed. Based on this examination, the testers were asked to discuss the issues that had caused the most confusion, such as rejection of adjectives, language skills, partitioning requirements, and the values that the company presents.

After the test group had agreed to the rules, each of them analyzed the same 30 randomly selected advertisements. These advertisements went through the same procedure as the first set. After the adjustment with terms, the average amount per person decreased, varying between 12 and 19 per advertisement. The summary of the number of terms in advertisements in this annotation is presented in Table 8.

Table 8: Summary of recognized terms by participants and *JobSkillSearcher*.

Irrelevant terms	Recognized terms	N	Mean	Var.	Annotator
35 198	3 118	38 316	0.082	0.075	All annotators
5 819	567	6 386	0.090	0.082	Person 1
5 819	567	6 386	0.090	0.082	Person 2
5 852	534	6 386	0.084	0.077	Person 3
5 863	523	6 386	0.083	0.076	Person 4
6 020	366	6 386	0.058	0.054	Person 5
5 825	561	6 386	0.089	0.081	<i>JobSkillSearcher</i>

Krippendorff’s alpha for this set ($\alpha = 0.671$) indicates that the results had improved from the first round, but still the reliability with this set remains questionable, even among the human raters. To evaluate the performance of *JobSkillSearcher*, its collected results were added to the reliability test. Data was added to the test in its current form and the test was re-run with all the samples. As the results in Table 9 present, adding the results provided by *JobSkillSearcher* (annotator 6) worsened the alpha value for the test. As a comparison, reliability without annotator 5 is also presented. *D-obs* in the table stands for observed disagreement, i.e. mismatches between annotators in values for the same terms. *D-exp* is the expected disagreement that would occur if the annotation of terms was completed randomly.

Table 9: Krippendorff’s alpha values for the test.

Alpha	D-obs	D-exp	N	Annotators					
0.618	0.057	0.150	6 386	1	2	3	4	5	6
0.671	0.048	0.147	6 386	1	2	3	4	5	
0.637	0.057	0.158	6 386	1	2	3	4	6	

A rapid examination of the recognized results revealed some major differences. Naturally, there are skills presented in various forms that *JobSkillSearcher* is not able to recognize (unless significantly improved). But some of the differences are caused by combined technological terms, such as “*MS Dynamics CRM*” recognized by all the human annotators. *JobSkillSearcher* instead recognized three different terms, “*MS*”, “*Dynamics*” and “*CRM*.” This example alone produces four inconsistent samples as compared against human annotators. Combining these types of samples (63 separate terms combined into 36 new terms, with duplicates removed) from the results alone improves the alpha to 0.648. It is to be noticed that after this technical change, the application (annotator 6) outperforms one of the human annotators when this is compared against the rest of the group (see Table 10).

Table 10: Krippendorff's alpha after unifying identified terms.

Alpha	D-obs	D-exp	N	Annotators					
0.648	0.052	0.148	6386	1	2	3	4	5	6
0.671	0.048	0.147	6386	1	2	3	4	5	
0.672	0.051	0.156	6386	1	2	3	4	6	
0.708	0.046	0.157	6386	1	2	3	4		

When one compares these *JobSkillsSearcher* and human results to the earlier research by Litecky et al. [Lit10], it can be noted that they limited the set of skills to 69 skills, which results in completely different conditions for concentrating on finding each single skill. The ambitious objective for *JobSkillsSearcher* is to identify all potential skills from the advertisements. However, a small gap remains between the human and computer analyzed advertisements. This gap can begin to be closed by improving the vocabulary and thesaurus, but a more significant improvement would require enhanced identification methods. Since the identification of terms is conducted by parsing the advertisements and single terms, not by analyzing the text at the level of sentences, skills embedded within verbose presentations of requirements are often not detected. This step would require a considerably higher quality of semantic analysis of the content. However, while manual classification of advertisements is slow (in the test, the time spent for a single advertisement per person took longer than 6 minutes on average) and thus expensive, and while the consistency between human annotators is also a challenge, these results show that using a computerized solution allowing masses of advertisements to be analyzed in a short time and with minimal cost is justifiable when using the results to demonstrate relations between different skills and their frequency in general.

3.3.2 Results

The relevance of the information collected from the advertisements can also be evaluated by comparing it to other research. The popularity of programming languages can be used as an example for demonstrating the results that the application has collected. Popularity can be defined and measured in various ways. For example, it can be based on 1) the number of new applications written in the language, 2) existing applications written in the language, 3) the number of developers and organizations that use the language primarily, 4) web searches, 5) job vacancies requiring skills in the language, or 6) developers' opinions. Table 11 compares results of the popularity of programming languages collected by different methods to the results that have been found from Finnish job advertisements using *JobSkillSearcher*. The ratings of Tiobe are based on the number of skilled engineers world-wide, courses, and third party vendors; and the ratings are calculated using Google, Bing, Yahoo!, Wikipedia, YouTube and Baidu [Tio11]. The results collected from Dice [Dic11] are based on searches for vacant positions at the end of September of 2011. Furthermore, the two following studies dating back to the past decade deal with the same matter. Evans Data's Fall 2006 North American Development Survey [Eva06] included more than 430 developers in North America. In Computerworld's [Com05] study, 966 out of 45 308 of their random subscribers answered the question: "Which programming languages are currently in use at your company for development?" The results of these sources are parallel and also support those collected using *JobSkillSearcher*. The proportion of the results from job

advertisements is calculated by comparing the occurrences to the number of advertisements where some programming language has been mentioned.

Table 11: Comparison of popularity between different programming languages.

#	Evans data (2005)	Computerworld (2006)	Tiobe (2011)	Dice (2011)	JobSkillSearcher (2011) (2012)
1	Java 45.0 %	C# 72.0 %	Java 18.8 %	Java 36.8 %	Java 35.9 % 34.6 %
2	C, C++ 40.0 %	Java 66.0 %	C 18.0 %	JavaScript 22.5 %	JavaScript 18.1 % 17.4 %
3	C# 32.0 %	Visual Basic 62.0 %	C++ 8.8 %	.NET 21.8 %	C++ 16.0 % 14.7 %
4	Ajax* 28.0 %	C++ 54.0 %	C# 6.8 %	C# 18.0 %	C 15.8 % 12.9 %
5	Visual Basic 21.0 %	JavaScript 50.0 %	PHP 6.6 %	C++ 13.9 %	C# 14.8 % 12.4 %
6	& VB.NET	Unix Shell Scripts 42.0 %	Objective-C 6.2 %	Perl 11.2 %	PHP 13.8 % 13.2 %
7		Perl 34.0 %	(Visual) Basic 4.4 %	C 9.8 %	.NET 9.3 % 8.3 %
8		C 32.0 %	Python 4.0 %	PHP 6.9 %	Python 6.2 % 6.1 %
9		PHP 16.0 %	Perl 2.5 %	Python 6.2 %	Ajax 5.4 % 6.9 %
10		Python 8.0 %	JavaScript 1.5 %	Ruby 3.8 %	Perl 3.6 % 4.3 %

* = Ajax considered as a programming language in Evans Data's survey and therefore included in results of *JobSkillSearcher*.

The differences among different sources are due to the methods used for collecting the information and the time difference of these studies. It may be presumed that there are differences between which programming skills are sought and which skills are already covered by the experts employed by the companies. For example, C-language is widely used in organizations and mastered by many ICT professionals. However, its role in job seeking is not as important as more modern programming languages, such as Java and C++.

Table 12 represents the analysis of skill frequencies in job advertisements collected with *JobSkillSearcher* compared to the responses from alumni provided in Likert-scale form about the importance of the skills in the world of work from the previous research of LUT presented earlier in Table 5. Only those skills covered in the alumni questionnaire are listed from the results of *JobSkillSearcher*. Within the results collected from job advertisements, the differences between the frequencies of the skills in advertisements are remarkable, whereas based on the questionnaires, most of the skills are considered important. There are also several skills missing in the alumni questionnaire but considered important by *JobSkillSearcher*, such as ability to do independent work, innovativeness and working under pressure; these skills could be added to the questionnaire.

Comparing the linear correlation with these two independent results arrived at through different methods reveals that there is a correlation between how important the employees have experienced the skills to be and how often these skills are introduced in IT sector job advertisements (Pearson's correlation coefficient $r = 0.604$; Spearman's rank correlation, corrected $\rho = 0.756$), but it remains questionable. However, the results encourage using the content of job advertisements for also evaluating the importance of different skills in the world of work, not just for immediate employment. Recognizing these skills and communicating them to students can be done to help students realize the actual importance of the skills.

Table 12: Importance of soft skills based on the alumni surveys of LUT and compared to the IT sector advertisements

Skill	LUT Research		Job advertisements from DB of <i>JobSkillSearcher</i>	
	Importance (scale 1-6)	Rank	Frequency	Rank
problem solving skills	5.43	1	0.0945	2
systematic thinking skills	5.38	2	0.0435	5
analytical thinking skills	5.38	2	0.0233	7
team working skills	5.10	4	0.0751	3
social skills	5.10	4	0.0730	4
communication skills	4.90	6	0.1022	1
organizing skills	4.65	7	0.0170	8
coordination skills	4.65	7	0.0156	9
presentation skills	4.65	7	0.0112	10
negotiation skills	4.50	10	0.0078	11
management skills	4.30	11	0.0262	6
teaching skills	3.90	12	0.0004	13
entrepreneurship-spirit	2.98	13	0.0053	12

When looking at the foreign language skill requirements that are listed in job advertisements, one takes note of the role of English. English language skills are highly appreciated, whereas Swedish, being the other official language in Finland, does not have that important of a role. The importance of Swedish in ICT jobs is probably even less significant, since the terms “Ruotsi” (“Sweden”) as a country and “ruotsi” (“Swedish”) as a language are not distinguished from each other by the application. The results are presented in Table 13.

Table 13: Frequency of language skills in advertisements.

Skill	LUT Research		Job advertisements from DB of <i>JobSkillSearcher</i>	
	Importance (scale 1-6)	Rank	Frequency	Rank
English language skills	4.98	1	0.397	1
Swedish language skills	1.85	2	0.099	2
Russian language skills	N/A	N/A	0.015	3
German language skills	N/A	N/A	0.012	4

One of the valuable outcomes of the research is the list and categorization of different terms recognized from the advertisements. The collection of terms is a good starting point for anyone who would like to categorize elements of ICT job advertisements. The occurrences of identified terms (with declensions) in selected categories, including different types of skills, locations, education-related terms and companies, are presented in Table 14.

Table 14: Occurrences of recognizable terms in different groups of classification.

Skill type		Occurrences
Hard skills	Programming languages	295
	Web programming	314
	Databases	180
	Markup languages	21
	Operating systems	123
	Others	116
Language skills		161
Soft skills		1707
Companies		250
Locations		336

Recognizing the skills that are potentially useful for employment is one of the steps and a point of departure when a student starts to consider the skills that s/he should acquire. It yields a better basis for personal development planning but is not the only information needed before the planning of studies is at hand. More help can be attained when universities also become aware of the skill requirements and introduce related issues as a component of courses and course descriptions. The importance of soft skills and language skills was presented in Table 14, and this should also be taken into account in universities when the institution provides information about courses and course content.

The application and information that has been collected have been used to show the similarities between the teaching plan of a web programming course held at Lappeenranta University of Technology during the academic year 2010-2011 and the requirements found from job advertisements. Figure 15 presents the content of the

exercises in the course compared to the results provided by the implemented tool. “HTML” was used as the search key, and the importance of the techniques that were taught in the exercises followed the results from the advertisements with the presented two major skill categories, “web programming” and “databases”. In demonstrating the results to the students, they are given evidence that the teaching plan and course contents are reasonable.

CT30A3200	WWW-SOVELLUKSET	7 op
	Webbed applications	
	Korvaa opintojakson CT30A3101 Web-ohjelmointi, mutta voi sisältyä samaan tutkintoon.	
Ajankohta Opettaja(t) Tavoitteet	TKK 3, periodi 1-3 dosentti, TKT Jouni Ikonen Opintojakson tavoitteena on tutustuttaa opiskelija WWW-ohjelmointitekniikoihin, -arkkitehtuureihin ja -toteutusvälineisiin. Opintojakso tarjoaa opiskelijalle valmiudet suunnitella ja toteuttaa vuorovaikuttaisia WWW-sovelluksia, huomioiden erilaiset tavat sovellusten käyttöön.	
Sisältö	WWW-sovellusten arkkitehtuurit ja standardit. Ohjelmointikielät ja rajapinnat vuorovaikuttavien asiakas- ja palvelinsovellusten luontiin (esim. JavaScript, PHP, Ajax). WWW-sovellusten sisällön tehokas hallinta ja julkaisu (tietokannat, RSS, julkaisuajastelmat).	
Suoritustavat	Luentoja 14 h, harjoituksia 12 h, kotitehtäviä, 1. periodi. Luentoja 14 h, harjoituksia 14 h, kotitehtäviä, 2. periodi. Virtuaalitehtävät 21 h, harjoitusten teko 39 h, 1.-2. periodi. Harjoitustyö 61 h, demontroittilaisuus 7 h, 3. periodi. Kokonaismitoitus 182 h.	
Arvostelu Oppimateriaalit Edellytykset	0 - 5. Jatkuva arviointi (kotitehtävät ja tuntikuulustelut) 50 %. Harjoitustyö 50 %. Luennoilla ilmoitettava materiaali. CT60A0200 Ohjelmoinnin perusteet, CT30A2002 Tietoliikennetekniikan perusteet, Suositellaan CT60A4301 Tietokannat.	
Lisätietoja	Opintojakson harjoitusryhmiin ilmoittaudutaan WebOodissa.	

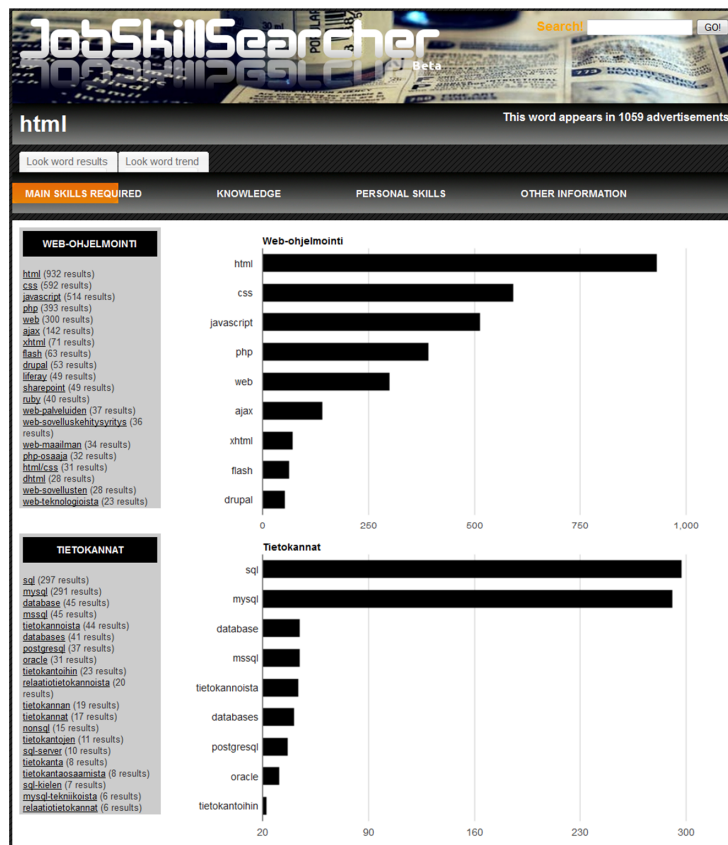


Figure 15: A web programming course description is compared to two major skill categories of job advertisements, including “html”.

3.4 Discussion

This chapter presented a tool to provide more exact information about skill requirements for job applicants. The goal is not only to provide this information but to consider how it can be used to support the entire learning process at the university. In the exploration of vocational goals, an important factor is the industry that defines the skills sets required in different positions. University representatives likely possess the knowledge to incorporate most of the technical requirements into teaching, but these requirements, their importance and their relations are not necessarily clear to students.

Brooks and McKinna [Bro11] have researched pedagogical issues to support student engagement with the personal development planning process. Their goal was to help students to recognize the full range of their skills and abilities in order to improve their employability skills. They found out that to make the process successful, students have to be motivated enough to engage in it. By providing more exact information about the industrial requirements and the learning outcomes of the courses on a broader scale, students are given a better opportunity and a basis for creating higher level development plans. These plans also guide students towards more precise target-oriented study planning.

Tools such as *JobSkillSearcher* for gathering and presenting real-time information about the requirements in job markets can be used to convince students and provide them with better opportunities to obtain a general picture of the possibilities and requirements. So far, precise information for the students about all of the skills, their importance, and especially the combinations of skills that they should possess has not been provided. Now, some information can already be provided, and more is being continuously collected. This information can be used to represent the importance of hard skills and their relations, but also the importance of soft skills is revealed to the students.

Students can first and foremost use this information to prepare their personal development plan, and, in the academic context, also prepare their personal study plan. The development plan and personal goals act as a basis for the beginning of the e-portfolio construction cycle. The selection of courses to be studied and thus included in the study plan is mainly based on the requirements that are set in curricula. However, students often have a chance to select between fields of specialization, some of the modules, and some of the courses within these modules. In an optimal situation, the selection should be based on the content of the courses, thus supporting one's personal learning goals. To help the selection, it is useful to know the outcomes of the courses – including those involving both hard and soft skills – to know the requirements and possibly even forthcoming trends in industry, and to be aware of one's personal preferences of learning. Hence the personal study plan should be constructed in order to support one's career comprehensively: knowledge and skills should be extensive enough, but some deeper, more detailed skills can also be highlighted.

The lack of skills alumni have at the beginning of their careers seems to correlate with our analyses of the courses in the Department of Information Technology at LUT. Among the listed challenges of the research, there are issues such as insufficient skills for seeking a job, insufficient knowledge of the world of work, and the uncertainty of one's personal skills and personal goals. These all are potential areas for improvement and are dealt with by the university as a part of the study guidance and personal development planning of students. Bringing the information to the students to support

their decision-making when they select the courses or when they struggle with motivation issues is a more important goal.

For a student, setting these goals can be made easier when the goals are more concrete and can also be identified at a lower level – as actual skills – not just at a high level, such as in the case of job titles. There are numerous students who wish to be programmers, consultants, or managers without knowing exactly or even roughly which kinds of skills are required for these jobs. Hard skills are probably easier to identify, but the higher the level of the job, the more emphasis is placed on interpersonal skills and soft skills. Students may not be aware of the meaning and level of these skills. Pointing out these skills and their importance in a concrete way will help students to recognize and collect evidence of these skills for their personal e-portfolios.

With the tools that were introduced in this chapter, more exact information can be provided to students for making decisions and for showing how extensive the required skills are. After becoming aware of one's own personal strengths and weaknesses (in learning, for example), the strengths can be emphasized as competitive advantages and knowledge can add to them, whereas the weaknesses can be improved upon. After recognizing personal abilities better, students are able to use the tools and compare jobs based on their personal preferences, whether pertaining to hard skills, soft skills or something else.

However, the information provided to the students must only support decision-making, not actually make decisions for the learner. By way of example, although Java is the most popular programming language based on job advertisements, even now only 35% of the programmer positions relate to it. Therefore, not all the students searching for a programming job need to master Java; there is demand for other experts of less popular languages, as well. Thus, the more important outcome that can be used in development planning are the secondary skills; when the student already recognizes his or her expertise and interest, skills for more extensive know-how can be pursued.

Based on the collected information presented in this chapter, some congruencies can be found:

1. According to IT graduates, there are gaps between the importance of and need for some soft skills in industry and the learning/development of these same skills during studies.
2. The importance of and demand for these skills can also be identified by exploring job advertisements and listed requirements. This analysis can be completed automatically with a software tool of satisfactory quality.
3. The analysis concerning our courses and the teaching provided confirms that there is room for improvement in teaching and the methods being used.

The information collected with the tool represents the general skill requirements in the industry. Thus, it is not aimed to be used as a tool providing all possible information when a certain job is being applied for. When a student is applying for a certain job, s/he should mostly be answering to those requirements expressed in the advertisement, not the ones that are commonly required for similar jobs. This, once again, underscores the importance of the learning process as a component of e-portfolio construction and

the principles of the introduced applications in this thesis: providing help in different stages of learning cycle and guiding from the project-based approach of e-portfolio construction towards a process-based one.

4 Supporting personal development planning

IT students use numerous applications to produce and collect information related to their studies. These may be generic applications for word processing, development tool sets for programming or various other purposes or systems that are provided by the university, such as online virtual learning environments (or learning management systems) or student information systems for enrollment and management of personal information and results. These generic applications are mostly related to the artifacts that are being constructed and used to complete assignments and indicate accomplishments, thus showing the learning outcomes of a single course. After completing the course, these artifacts are often discarded and will not be used for any purposes at a later date. These artifacts could be used as proof of skills and personal development.

However, before being able to take advantage of these artifacts, students should be able to identify the actual meaning of them more precisely and see how important they are along the students' trajectory towards developing into skilled professionals. This means that in the background, there are goals to be achieved, tasks to be accomplished, and tools to be used to improve and follow one's personal development. The ability to give more exact information about the skills that are demanded by industry and covered in teaching can be valuable when students make personal development plans. The role of universities and the study guidance universities provide to students are important and support this development.

Terry O'Banion [Ban72] has discussed the academic guidance model and has listed five requirements for the process of academic guidance:

- exploration of life goals;
- exploration of vocational goals;
- program choice;
- course choice;
- scheduling courses.

The approach taken in this thesis is mainly based on the same requirements, apart from the exploration of life goals. The focus of the previous chapter was to present technological tools that support the students in exploring their vocational goals. These vocational goals should act as basis in decision-making when students are deciding what they will major in, and are selecting and scheduling the courses in their study plans. To support these academic guidance steps at a more technical level to help students to

organize and manage their personal study plans, a tool called *WebTUTOR* was implemented at LUT. Its development is described in *Publication 4*.

The role of personal learning styles can be considered as an important element of personal development and planning. Each student has individual preferences in terms of learning, and if the methods used in teaching are not well balanced, they are not likely to be suitable or optimal for all students. Having too much emphasis on one preference at the expense of another may be harmful to the learning process, but the student may not necessarily even recognize it. If the personal learning styles and the course information are presented to students, it can also support personal development planning. If students are willing to pay attention to the development of their strengths and especially weaknesses, there is also a chance for improving and balancing these preferences.

Since different learning style models are based on psychological types, they can also be considered to relate to soft skills. Moreover, more attention should be paid to teaching styles and methods, and the possibility for sharing this information in more detail with students, as presented in the previous chapter, should be considered. This is an important issue, since personal preferences and learning styles affect the decisions that students make when selecting the courses they take. This chapter approaches personal development through both study planning and discovery of learning preferences.

4.1 Personal study planning as a part of development planning

The concept of planning one's personal studies and development has various interpretations. Different terms are used to define the scope and meaning of the plans. The comprehensiveness, profoundness, and the level of individuality of the plans can be used to define and separate these terms.

Considering planning in a more extensive context encompassing the personal goals and skills to be achieved, the term that best describes it is "personal development planning" (PDP), sometimes also referred as "individual development planning" (IDP). It refers to "a structured and supported process undertaken by an individual to reflect upon their own learning, performance and/or achievement and to plan for their personal, educational, and career development" [Amb01], [Jac01]. Being highly related to the process and the objectives of students, development plans are updated and made more specific, or even completely redone when the individual's personal interests and goals become clearer through personal development and experiences. The aim of these plans is to help students to outline their personal goals of development in order to determine the courses of action to reach these goals [Ans06]. By setting goals, planning, and reflecting one's own achievements against one's objectives, individuals have better tools for becoming aware of their personal competencies.

As development towards goals is mainly carried out by learning, the individual learning plan (ILP) is a tool encouraging concrete actions to achieve these goals. It is an individual strategy for choices related to learning, where personal goals and strengths such as learning styles are taken into account. It can identify development activities to improve the knowledge and skills required [Fei03]. Lahenius et al. [Lah10] have approached personal study planning from the doctoral student point of view and defined it as an ongoing process which lasts throughout one's studies. In addition to the individual learning plan, the concepts of the individual study plan (ISP), personal study

plan (PSP) and personal learning plan (PLP) may be used to denote almost the same issue [Ans06].

The difference between personal study plans and personal development plans lies in the extent of the plan and its connection with degree structures. Lahenius et al. [Lah10] have summarized that personal study plans are connected to curricula and degree structures [Ans06], whereas a personal development plan is a more extensive process for the individual student [Jac01] and can also be considered as a tool for reflective learning [Hig02]. The differences between these two approaches (partially based on a study by Annala [Ann07]) are collected in Table 15.

Table 15: Comparing definitions concerning PDP and PSP planning.

Personal Development Plan (PDP)	Personal Study Plan (PSP)
Individual	Individual / Organization centric
Self-directed	Organization directed
Private	Shared for administration
Aims at personal development	Aims at academic curriculum
Based on long-term goals	Based on rules and regulations
Open-ended, "unwritten"	Narrow, "written"
Defines the target state	Sharpens the near-future actions

In Finnish research, the “personal study plan” is a commonly used term related to personal development. The meaning of the term typically includes a wider scope than the one defined earlier and used in this thesis. The terms as used in the 1990s may cause some confusion today. Then, PSP was divided into two areas, narrow and open-ended study planning; this conception has been used e.g. by Laitinen [Lai94]. Narrow study planning is more or less a tool for selecting courses to meet the requirements defined in the curriculum and for scheduling the selected studies. A narrow study plan is a technical and unambiguous tool; in contrast, an open-ended study plan refers to self-directed plans for personal development. Hence, the narrow study plan can be considered as a personal study plan and the open-ended study plan as a personal development plan, according to the earlier definitions.

The items in O’Banion’s academic guidance model [Ban72] can also be used for one to deliberate about the difference between the terms “personal study planning” and “personal development planning.” As in this thesis, PSP is used to describe the plan in the context of the educational institute, representing a concrete plan of studies at the level of single courses and their scheduling based on the requirements of the curriculum. Personal study planning is more related to the three last items in O’Banion’s requirements. Respectively, personal development planning more or less covers all of these requirements, emphasizing the first two. Personal study planning can thus be considered as a tool for personal development planning.

The role of personal development plans in many respects converges with that of portfolios. In the definition used in this thesis, a study plan is future-centric and includes low- and high-level plans and goals. The information that is created in study plans, while reflecting completed studies, is essential as it relates to the basis of portfolios. Based on Annala’s [Ann07] findings, PSP is a reasonable tool when it is fully integrated into pedagogical planning and practices. In the best case, students have benefitted from

the guidance they received for their PSPs, having an effect on learning, on planning their studies, and, when considering personal development, also on planning their careers. Goals are defined in study plans in the form of courses and course modules, and reflection is completed after experience and knowledge have been gained in the learning process.

4.1.1 The role of study planning in Finnish universities

As a consequence of the Bologna declaration, degree programs at Lappeenranta University of Technology were divided into two cycles. The first cycle is the degree for Bachelor of Science, which must be completed before the second cycle, the degree of Master of Science. These degrees are divided into smaller modules, which include a number of courses. Figure 16 describes the structure of studies as modules based on the Study Guide 2010-11 of LUT Information Technology.

Master of Science	General studies (12 ECTS)	Major subject (78 ECTS)	Minor subject (20 ECTS)
			Elective studies (10 ECTS)
Bachelor of Science	General studies (107 ECTS)		Major subject (42 ECTS)
			Minor subject (20 ECTS)
			Elective studies (11 ECTS)

Figure 16: The structure of B.Sc. and M.Sc. degrees in 2010-11 at the Department of Information Technology at LUT.

The modules consist of a varying number of courses and credits to be achieved. Some of the modules comprise compulsory (obligatory) courses. In some cases, courses may be interchangeable (exchangeable) or the student may select a sufficient number of courses to fulfill the credit requirements. One of these modules, the major subject in the degree of Master of Science including 78 ECTS credits, is presented in Figure 17. It indicates associated compulsory, interchangeable and elective courses.

5.1.2 MAJOR: Communications Software

Major Subject in Communications Software

<i>Obligatory Studies (53 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
CT30A5000	Network Programming	M.Sc. (Tech.) 1	1-2	5
CT30A6000	Communications Software, Protocols and Architectures	M.Sc. (Tech.) 1	1-3	8
CT30A8001	User-Centric Service Design	M.Sc. (Tech.) 1	3	5
CT30A8902	Service Oriented Architecture	M.Sc. (Tech.) 2	2	5
CT10A6000	Master's Thesis and Seminar	M.Sc. (Tech.) 2	1-4	30

<i>Elective Studies (min. 25 ECTS cr)</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
CT10A9100	ECSE International Summer School in Novel Computing	M.Sc. (Tech.) 2	int.	1-2
CT10A9601	Research Methods, Laboratory Project	M.Sc. (Tech.) 1	1-4	1-5
CT10A9700	Summer School on Communications Engineering	M.Sc. (Tech.) 2		2
CT30A6801	Local Area Networks, Special Course	M.Sc. (Tech.) 1-2	1-3	8
CT30A6900	Peer-to-peer Networking	M.Sc. (Tech.) 1-2	3-4	5
CT30A7001	Concurrent and Parallel Computing	M.Sc. (Tech.) 1-2	3-4	8
CT30A8300	Wireless Service Engineering	M.Sc. (Tech.) 1-2	1-2	5
CT30A8800	Secured Communications	M.Sc. (Tech.) 1-2	1-2	6
CT30A9300	Code Camp on Communications Engineering	M.Sc. (Tech.) 1-2		4
CT30A9400	Ad hoc and Sensor Networks	M.Sc. (Tech.) 1-2	1-4	5
CT60A7201	Architecture in Systems and Software Development	M.Sc. (Tech.) 1	3-4	7
CT60A7302	Software Quality, Processes, and Organizations	M.Sc. (Tech.) 2	1-2	7
CT60A7400	Fundamentals of Information Systems	M.Sc. (Tech.) 1	1-2	7
CT60A7500	Object-Oriented Programming Techniques	M.Sc. (Tech.) 1	1-2	5

Figure 17: A module containing obligatory and elective studies for the major subject [Lap10a].

When there is more freedom of choice, the students' responsibility for constructing a reasonable plan also increases. Most of the Master's level courses have prerequisites for knowledge and skills (typically achieved in other courses) that students should fulfill. This highlights the importance of careful study planning: if choices are made only for the short term, the student may not adequately fulfill the prerequisites. Therefore, it is important to prepare the plan early in one's studies, to maintain and update it continuously and also to track the completed courses.

The amendment to the Universities Act (556/2005) [Fin05a] entered into force in 2005. As a consequence, a maximum duration was set for the completion of the Bachelor's and Master's degrees. Additionally, in the negotiations between the Ministry of Education and Finnish universities [Fin05b], an agreement was made to adopt personal study plans into use by the year 2006. As a consequence, the universities started to direct more attention to personal study planning. As the number of university students and their freedom of choice regarding courses increased, more resources were required for study guidance. This created an interest towards more sophisticated solutions for study planning and the management of the plans.

According to Annala [Ann07], there are also other reasons why more attention has been paid to study planning. On one hand, the aim is to make the studies more effective by shortening the length of time for completing them. On the other hand, the aim is to educate more competent employees for industry having particular "meta-skills" regardless of the degree. The transferability of these skills should be rapid when moving from one position to another. In fact, the role of study planning has slowly changed from a tool used by a university to verify that the plan follows regulations to a tool used by students to plan their development.

4.1.2 Providing assistance for study planning with software applications

As the need for study guidance takes up resources from advisors, in many instances projects have been set up to design and implement software applications to support the mechanical steps in both the construction and acceptance of study plans. Traditionally, study planning involved listing the courses that the student planned to take by filling out different forms and delivering them to the study guidance staff. In some cases, students were provided templates, e.g. in spreadsheet form, which they used to organize the courses that were to be included in the degree. These sheets were more or less technical tools for university administration 1) to ensure that the students had appropriate plans for their studies, 2) to provide a common template to ease students' work and to have the plans in desired form for study advisors, 3) to follow the progress of the studies according to the plans, and 4) to verify the requirements for the degree at the end of the studies before graduation. These documents were only simple lists of courses, probably including their scheduling. All automation was lacking, such as showing the fulfillment of regulations of the plan for the student, which needed to be carried out manually, and verifying the fulfillment of prerequisites before taking a course.

Because the management of separate versions of documents and printouts was not efficient and the automatic handling of these was virtually impossible, software applications have been developed to support personal study planning. Application driven planning is able to make the process not only more effective, but also more informative. The automatic verification of course prerequisites can be incorporated to help planning, substitutive courses can be defined, and modules in curricula can be created. All of this information can be used to support the planning process that the student has to go through when building his or her first plan and also later when modifying and updating it. The plans can automatically be verified against regulations using the structure modeled in database. In addition, there is a centralized service where all plans are stored for later access.

The tools for personal study planning from the academic perspective have been implemented in various institutes, and almost without exception, they have been web-based tools. Jensen and Nielsen [Jen03] have implemented a .NET-based study planning system for the Technical University of Denmark, which was to be used to support automated study planning in the long term. A set of courses compose a Technical Package that must follow the defined regulations; they eventually comprise the degrees of Bachelor and Master of Science. Scheduling of the courses for the longer term, not only for the near future, is also supported.

Segura-Ramirez et al. [Seg06] introduced a prototype named the Study Planning System to aid student guidance. The idea behind their solution is more progressive: to collect past graduate records as templates for study plans of curriculum patterns, which are then used to help new students determine a study pattern for their needs. Albaloooshi and Shatnawi [Alb10] have presented a system called HE-Advisor. It can be used to help students, for example by proposing courses for them for the following semester, as it compares the student's degree plan against the courses that the student has passed and the list of uncompleted courses. In addition, there has been a wide variety of smaller and local implementations, such as the Intelligent Student Information System [Nor03] and Frosh2 [Sie03].

Compared to traditional course recommendation systems Farzan and Brusilovsky [Far10] have taken a different type of approach by implementing CourseAgent, a community-based recommender system. The system attempts to predict the relevance of courses compared to students' lists of career goals. Ratings for courses are provided by a community of students after completing their courses based on the list of goals. They have motivated students to give feedback for the courses by implementing a career progress feature that considers only those rated courses against their career goals.

In Finland alone there have been numerous projects where institutes have developed study planning systems for their own needs. Desmond [Ryt03] at the Department of Computer Science at the University of Helsinki, eHOPO [Hak05] at the former University of Joensuu (currently the University of Eastern Finland) and Korppi [Ruu07] at the University of Jyväskylä have all been designed and implemented to support study planning. Moreover, at the University of Turku, a tailor-made study planning tool called SOPS was developed to support the study guidance system [Män05], to make the students' graduation process more efficient, and to support study guidance personnel to provide students with the best possible skills and knowledge for their careers.

A common factor for applications for academic purposes is that they have typically been used only at the institute where they were developed. Even if the applications are adaptive, have not been designed only for the organization's internal use, and have been shared as open-source, they have not ended up in use at other institutes. Although the need for solutions to make student guidance more effective has been addressed, Pitkänen [Pit11], Kristensen [Kri11], and Siegfried [Sie11], who all have been involved in development of the tools listed earlier, have pointed out in private discussions that most of these tools have had short life-cycles and a low level of support even in the case of the corresponding institutes and their administration. Software tools had been considered as a good solution and tests regarding the applications had proven their usability, but the tools never obtained official status. The question is, why?

As the tools originate from typically university or department-driven systems implemented as part of developmental projects, there have not been efforts to provide and guarantee support for maintenance. Since the university-level support in the long term for these tools has been unclear or unforthcoming, the integration of these systems as a component of study guidance has been weak. As these tools are "unofficial" from the university point of view, responsibility for the advertising of them to students has fallen to individual teachers. Once again, integration into university processes is lacking, both in terms of technology and guidance. From the administration's perspective, the introduction of these applications in many cases might have been easier if the administration's ownership of and maintenance responsibilities for the applications had been clearer and plainly outsourced.

Nowadays, the market in Finland is shared between three major players, each providing their solutions clearly for different target groups. A majority of Finnish universities are members of the Oodi consortium¹⁴ and have been using the WebOodi application for managing and storing the records and results of their students. Being earlier a tool for electronic registration for semesters, courses, and examinations, it currently also includes the degree structures and a tool for scheduling studies. Students can use the system to become acquainted with the requirements and build their personal study plan.

¹⁴ <http://www.oodi.fi/>

The member universities have one by one taken the study planning tool into use after it was published in 2007.

SoleHOPS¹⁵ is used by 11 Finnish universities of applied science. Utilization of the tool requires that the institution use their solution for course management, which makes this tool more comprehensive than a mere study planning tool. Modeling the curricula starts from the level of entire degree, divided into semesters. For a student, it is also a tool to communicate with his or her tutor, leave comments and receive feedback.

Wilma¹⁶ is a tool for lower and upper secondary schools in Finland used for selecting courses, following accomplishments, creating schedules, and communicating with teachers. It is also a comprehensive tool used for study planning, for managing the records of students, and for acting as a registration tool. The study planning features include selection of studies and scheduling based on periods and semesters.

4.1.3 Implementation of *WebTUTOR*

In 2004, the LUT Department of Information Technology recognized the need for a partially automated study guidance system for students. To facilitate some of the mechanical steps of creating and maintaining a student's personal study plan, a web-based standalone application, *WebTUTOR*, was designed and implemented. The application is described more precisely in *Publication 4*. One of the main design principles was that the tool has to serve the needs of the students in different phases of their studies. Freshmen can use the tool mostly for selecting suitable courses and scheduling their study path as far ahead as they can envision (in 2005, students at Lappeenranta University of Technology had to select their major at the end of the second year of studies, which in turn affected the courses that were available). In contrast, students at the end of their studies can use it for the final approval of their degree structure.

The needs of and starting point for students further on in their studies was also an important consideration, since most of the users of the system at the time were not freshmen, but still starting to create their plans with a varying set of completed studies. Not much attention or requirements had been given earlier to study planning at the university level, and therefore, many older students had no up-to-date plan or no plan at all for their studies. To help these students, the degree curricula were also modeled starting from the academic year 1998-1999.

Since the goal was to improve the practices of study planning at the time, advanced solutions to support the construction of study plans were needed. The first step of constructing a PSP is selecting the basic degree structure. As the structure of all the related courses with their attributes was provided, students were able to choose the modules they wished to include in their degree and the courses in each of the modules based on the modeled rules. This more or less guaranteed that the constructed study plans followed the rules but left the students the freedom and responsibility for selecting a reasonable set of courses. If the student had completed courses before creating the plan, their transcript of records was imported into the system, and automatic suggestions for transferring the courses into suitable modules were given.

¹⁵ <http://www.solenovo.fi/fi/tuotteet/soleops>

¹⁶ <http://www.starsoft.fi/public/?q=node/54>

Figure 18 represents the modules in an individual student's plan. It contains the names of the modules, the year from which curricula the module is taken and the number of required credits. Most of the modules are compulsory and automatically included in the study plan. The modules for the minor subject have been elective, which is demonstrated in the four lowest lines in the figure. Students can select the minor subject modules they desire from the curricula. The regulations also largely give students the freedom to select modules from the examinations from different years. This allows students to select the most suitable ones, which is especially useful when students have not completed their studies in the presumed timeframe and the courses in the curriculum have changed.

Tutkintorakenne

Tietotekniikka (2000)

Opintoryhmä	Vuosi	Ov	Muokkaa	Tutkintorakenne (Osasto / Opintosuunta)
Perusopinnot	2000	33.5		(Tietotekniikan osasto)
Aineopinnot	2004	40		(Tietotekniikan osasto)
Pakolliset opinnot	2000	45 - 45.5		(Tietotekniikan osasto / Tietoliikennetekniikan opintosuunta)
Aineopinnot	2000	11 - 11.5		(Tietotekniikan osasto)
Syventävät opinnot	2000	34		(Tietotekniikan osasto)
Vaihtoehtoiset opinnot	2000	27.5		(Tietotekniikan osasto / Tietoliikennetekniikan opintosuunta)
Aineopinnot	2000	11.5		(Tietotekniikan osasto)
Syventävät opinnot	2000	16		(Tietotekniikan osasto)
Sivuaineopinnot	2004	25		(Tietotekniikan osasto)
Tietotekniikan sivuaineopintoryhmä	2004	10	<input type="checkbox"/> Poista	(Tietotekniikan osasto)
Tuotantotalouden sivuaineopintoryhmä	2004	10	<input type="checkbox"/> Poista	(Tietotekniikan osasto)
Sähkötekniikan sivuaineopintoryhmä	2004	10	<input type="checkbox"/> Lisää	(Tietotekniikan osasto)
Teknologiayrittäjyys	2004	10	<input type="checkbox"/> Lisää	(Tietotekniikan osasto)

Figure 18: A view of the selected modules in a personal study plan.

Figure 19 presents a more detailed view of a single module entitled “*Syventävät opinnot*” (advanced studies, at present replaced by the major subject), including 34 credits in PSP following the structure presented earlier in Figure 17. In the view provided, course statuses are identified using four different colors which all have different meanings. The first course in the list, marked with a green background color, indicates a course that has been included in the plan (and in the corresponding module) and has also been completed and graded. The next course in the gray background is also included in the module by the student, but has not yet been completed. Thus, the student has a possibility to schedule it in future semesters. Since the availability of the courses and their placement in semesters in the future could not be guaranteed by the university, students were given a chance to place them in the semester they wanted. Further down the list, there are two courses in yellow. These courses are electives and, as explained in the footnote, interchangeable with each other. The last course in red has not been added to the module by the student, but it is compulsory. By providing this information automatically, the system aspires to efficiency and good usability in constructing study plans.

Syventävät opinnot 34 ov						
Nro	Opintojakson nimi	Arvosana	Ov	Huom.		
010680000	Tietoliikennetekniikan seminaari ²	4	2			[Muokkaa] [Siirrä]
010715000	Tietotekniikan erikoistyöt		7	Raportti	Syksy 2004	[Muokkaa] [Siirrä]
Nro	Opintojakson nimi	Ov	Siirrä suunnitelmaan			
010626000	Lähiverkot -erikoistyykurssi ¹	5	<input type="checkbox"/>	Ystävää opintojaksoa...	Korvaa suorituksella...	
010666000	Optical Communications ¹	5	<input type="checkbox"/>	Ystävää opintojaksoa...	Korvaa suorituksella...	
DI-työ	Diplomityö	20	<input type="checkbox"/>	Ystävää opintojaksoa...	Korvaa suorituksella...	

¹ Keskenään vaihtoehtoiset opintojaksot.
² Keskenään vaihtoehtoiset opintojaksot.

Suoritettu: 2, Suunniteltu: 7, Yhteensä: 9
 Opintoviikkovaatimukset: 34

Figure 19: List of courses in a single module.

For effective learning (from the points of view of both the student and the university), a suitable study path is important. Typically, an advanced course has prerequisites, that is, courses that should be completed before entering the course. These prerequisites may be (compulsory) requirements or merely recommendations to ensure that the students have adequate skills to absorb the information taught in the course. As these relations are modeled in our database, they can be taken into account and used to verify the plan after the students have scheduled the selected studies. *WebTUTOR* includes a visualization tool for these relations; a partial representation of the relations between the courses selected by a student is depicted in Figure 20. This feature was implemented to visualize the learning path (compulsory prerequisites are marked using a red line with an arrow and recommendations are marked using a green line with a dot) and to help the student to add the required or recommended courses to his or her plan and also to schedule them in the appropriate order.

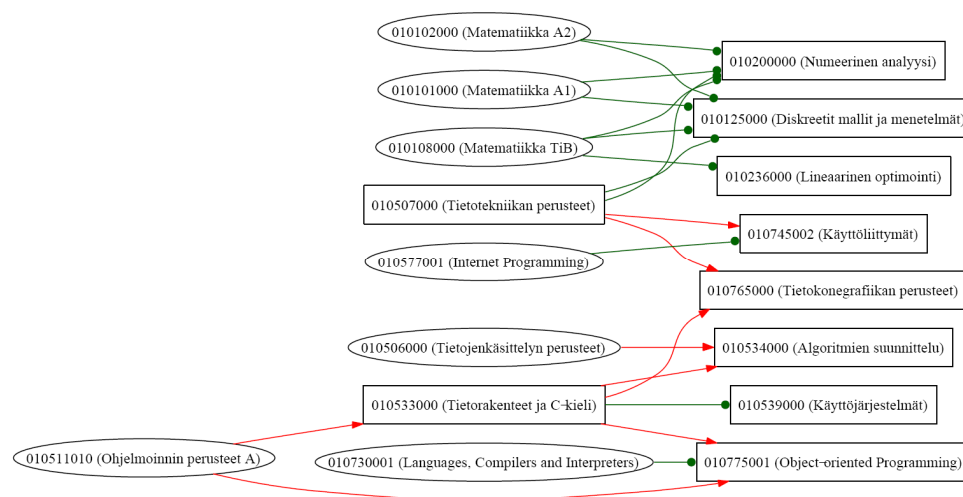


Figure 20: Relations of the selected courses to respective prerequisites.

As the final step after finishing the plan, students were able to send the completed plan to be approved by study guidance personnel and to print out the plan for their own

purposes. Study guidance personnel were given an interface with which to review and approve the published plans. Consequently, the goal was to support the construction of personal study plans and decrease the amount of work required both from students and study guidance personnel. The goal was not to implement a system that takes away the personal contact and interaction between students and staff but rather to provide a tool to help their work and ease the tasks that are mostly based on the regulations in the curriculum. Actually, one of the fears of the study guidance staff was that this type of tool would actually increase communication and interaction if all of the small changes students made to their plans would need to be approved by them.

4.1.4 Results

WebTUTOR went through a two-step usability test. In the first step, five pilot users tested the application for its features and usability. The feedback collected from this test was used to discover potential bottlenecks, but it was only evaluated on a technology basis.

The second phase of tests was completed after *WebTUTOR* was introduced. The test with five users who had never used the tool before paid more attention to the process of creating study plans. Each student was given a task to create a personal study plan using the tool. The test was run student by student in an isolated room, and the process was followed by the author of the thesis. The users were asked to work as if they were alone, and there was no communication between the users and observer. Each of the users had a need to create a personal study plan; therefore, they all seemed motivated for the task. After they had completed their study plans, a semi-structured interview was held. As a conclusion, four major points emerged:

- Everyone who had earlier manually created or tried to create a personal study plan endorsed the tool for its efficiency. Creating a valid study plan generally took them less than an hour. Their estimations of how long they had earlier spent time on creating a plan varied from two to four hours. Also, the ones who had not created a plan before spent about an hour to complete it during the experiment.
- The modeling of degrees, modules and courses and the separation of elective and compulsory courses in the modules were considered to be useful features of the system. In addition, automatic placement of completed courses into modules made the task more effective.
- The displaying of the missing courses in the modules made it easier to select correct courses and to schedule them.
- Importing a personal study record into the system by saving it from another system and uploading it annoyed all the users, and despite the step-by-step guide they were given at the upload page, it was felt to be tricky.

A web questionnaire was sent to a random set of registered users. Less than 10 students who responded to the questionnaire brought up exactly the same issues.

The fact that the tool was a standalone application and not a module in an existing system increased opposition to it among the administration and some of the study

guidance personnel. It was partially seen as a threat that would increase the workload of employees, although the goal/assumption was made that the total amount of work would have decreased compared to the prevailing situation and the printed plans. In addition to this, the positive sides of the tool for the students were not emphasized enough.

Similarly to many of the related systems, the life cycle of *WebTUTOR* was short. Lappeenranta University of Technology, as a part of the Oodi consortium, made the decision to wait until the tool for Oodi was finished, and did not commit itself to *WebTUTOR*. Published and taken into use at the beginning of the year 2005, *WebTUTOR* was used by the Department of Information Technology. In addition, the Department of Chemical Engineering modeled its degrees and tested the system with its students. As the Oodi tool was provided to students during the year 2007, *WebTUTOR* was no longer advertised to students by study guidance personnel.

Comparing the functions that *WebTUTOR* had provided for users to the existing solutions, it can be said that the implemented features do not pale in comparison. The development and implementation were done more for the need that was experienced, and research of the effects was neglected, also due to the short lifecycle of the tool. However, we at the department were among the pioneers in designing the features, the implementation, and the introduction of these types of applications. In addition to ours, many of the systems introduced at that time and which are no longer in use have functioned as prototypes for the features that have been adapted to subsequent personal study planning applications. In the process of constructing portfolios, personal study planning is a fundamental part, and it creates the basis for the development and reflection described elsewhere in this thesis and therefore reflects the importance of *WebTUTOR*, for launching this work was fundamental.

Table 16: *WebTUTOR* compared against currently widely adapted applications, including study planning features.

Tool	Used in	Supports multiple study plans	Scheduling studies	Modeled curricula	Selectable modules	Integrated with study record system
WebTUTOR	Department of Information Technology, LUT, 2005 - 2007	X	X	X	X	
Oodi	Currently in 13 Finnish universities	X	X	X	X	X
SoleHOPS	Currently in 11 Finnish universities of applied science	X	X	X	X	X
Wilma	Currently in lower and upper secondary schools in Finland	X	X	X	N/A	X

4.2 Recognizing personal learning styles

The student's learning style is one of the fundamentals of which the student starts to construct his or her portfolio, either consciously or unconsciously. After defining and

discovering the skills being taught and learned, the student has to consider how the skills relate to his or her personal interests, characteristics and styles for learning and doing things. A learning style defines which types of learning and teaching methods are the most suitable for better outcomes. Learning styles are often closely related to the soft skills that normally require more time to be improved upon, but play an even more important role than hard skills when advancing in one's career. Finding one's personal strengths and emphasizing them as well as identifying and supporting one's weaknesses may help later.

Learning style refers to the personal way of or approach to learning. Although all of us have an individual learning style, most of us are not aware of it and thus are not able to take it consciously into account while learning and making decisions based on it. Cognizance of these preferences could be put into better use during studies by paying attention to personal strengths and weaknesses.

Learning styles have been widely researched over the past decades. Various models and assessment methods have been developed to define and find out personal preferences. These preferences do not apply only to learning, but also to teaching. Teachers tend to plan and carry out their teaching emphasizing their own personal preferences and strengths. These preferences might appear to the student through the teaching methods of the courses.

4.2.1 Learning style models

One of the earliest learning style models is the Myers-Briggs Type Indicator (MBTI) [Mye98] developed in the 1940s and 1950s. Initially, it was developed for the purpose of examining personality types, but it can also be used to discover different learning styles. It is based on Psychiatrist Carl Jung's theory, introduced in the 1920s and suggesting that humans can be categorized into different personality types. The MBTI defines these types based on four pairs of preferences: introversion versus extraversion, sensing versus intuition, thinking versus feeling, and judgment versus perception.

Kolb's Learning Style Inventory (LSI) [Kol71] is a more recent model. The original Learning Style Inventory (LSI 1) was created in 1969 as part of a Massachusetts Institute of Technology (MIT) curriculum development project, and since then the model has been updated to the current version 3.1 published in 2005. In this model, two dimensions of preferences are compared: concrete/ abstract and reflective/active. The preferences create four separate entities, each presenting a characterizing question: what, what if, why, or how. To be able to measure the types, Kolb developed the LSI test, in which all four areas of the respondent are considered.

Another model, called the Herrmann Brain Dominance Instrument (HBDI), was developed by William E. Herrmann in the 1970s. The model classifies learners into four categories based on the physical functionality of their brains. Herrmann identifies four different modes of thinking: analytical, sequential, interpersonal, and imaginative. According to Lumsdaine and Lumsdaine [Lum95], the teaching of technology typically concentrates on analytical and sequential thinking. Just as in Kolb's model and in typical teaching preferences, unbalance is harmful to all students, but especially to the ones that belong to the two other groups.

Felder and Silverman's [Fel88] model of learning and teaching styles was published in 1988. It is based on the models of Jung, Kolb, Dunn, and Guild [Gui86]. Initially, the model consisted of five scales, but was later modified to include eight preferences of four scales: active/reflective, sensing/intuitive, visual/verbal, and sequential/global. Traditionally, teaching in universities of technology mostly emphasizes reflective, intuitive, verbal, and sequential aspects [Fel96]. Studies by Alaoutinen and Smolander [Ala10] and Savander-Ranne [Sav05] refer to Finnish engineering students as typically active, sensing, visual, and sequential, which seems to be in contradiction to typical teaching in universities globally, as defined by Felder.

Honey and Mumford base their model on the learning cycle divided into four parts: having an experience, reviewing it, concluding from it, and planning the following steps. Based on the likelihood of learning well from these experiences, learners are divided into four different categories: Activists, Reflectors, Theorists, and Pragmatists. The same cycle has been used to describe the major steps and actions in constructing a personal portfolio in this thesis.

A summary of the introduced learning style models is presented below in Table 17. It highlights how learners' preferences are classified based on these models. The purposes of these models are partly divergent, and some of them should provide more useful information than others regarding technology students in universities. The similarities as well as the differences between the models can also be identified.

Table 17: Summary of the presented learning style models and associated classification preferences.

Model	Type of learner / Preference	
Myers-Briggs Type Indicator (MBTI)	Introversion Sensing Thinking Judgement	Extraversion Intuition Feeling Perception
Kolb's Learning Style Inventory (LSI)	Concrete Reflective	Abstract Active
Herrmann Brain Dominance Instrument (HBDI)	Analytical Sequential Interpersonal Imaginative	
Felder and Silverman	Active Sensing Visual Sequential	Reflective Intuitive Verbal Global
Honey & Mumford	Activist Reflector Theorist Pragmatist	

Tests for finding out an individual's learning style

In order to determine one's learning style based on the models mentioned above, various tests have been developed. Typically, these tests present questions or statements followed by multiple-choice answers. Based on the answers, an estimation of the respondent's learning style can be made.

One example of these tests is the ILS (Index of Learning Styles) test. Richard Felder and Barbara Soloman developed the test based on their model in 1991 [Fel05]. They use 44 multiple-choice questions to calculate the results. To find out to what extent the types of Honey and Mumford's model apply to a person, the Learning Styles Questionnaire (LSQ) was implemented.

4.2.2 Improving learning outcomes by adjusting teaching

Concerning the university and teaching, it is interesting to see how important the role and effect of the students' learning styles may be for learning outcomes and if the results can be influenced by adjusting teaching. Various studies all over the world have been completed to collect students' preferences, including those of students at technical universities.

Some studies have shown that the results concerning an individual course are better when teaching methods match learning styles. Larkin-Hein and Budny [Lar01] have surveyed several studies which have highlighted that students' learning styles should be taken into account in teaching to fit the teaching to student preferences. One of the main reasons for better learning outcomes is likely to be that a teaching style corresponding to a student's learning style increases the student's motivation.

On the other hand, before teachers adjust their teaching, it is to be considered whether the teaching methods should be based only on the strengths of the students. On the whole, it might be questionable whether teaching methods are matched too perfectly with students' learning styles give enough stimuli for the students in the long run and develop students' comprehensive skills. According to Felder [Fel96], to promote the learner's development and good learning outcomes, these personal preferences should be well balanced, and the student should not emphasize any of these preferences too strongly. Litzinger et al. [Lit07] state that teachers should not tailor their teaching (plans) to fit the learning styles, since the optimal teaching style is also occasionally contrary to the student's preferences. However, since classrooms are not made up of a homogeneous set of students, adjusting the teaching methods to explicitly serve everybody's preferences is likely next to impossible. Therefore, the usage of wide-ranging methods where teaching is not merely based on certain preferences, but is also sometimes in contradiction with them, give students comprehensive tools for their future. A more interesting comparison from our point of view at the department is to compare the learning styles to the teaching methods and results and to examine if any trends can be detected.

A potential change in personal learning preferences is another interesting issue. According to Robotham [Rob99], research concerning the relative stability of learning styles has remained both "confused and confusing." He referred to sources claiming that the learning style of an individual remains unchanged or stable [Cor83], [Cla78], while

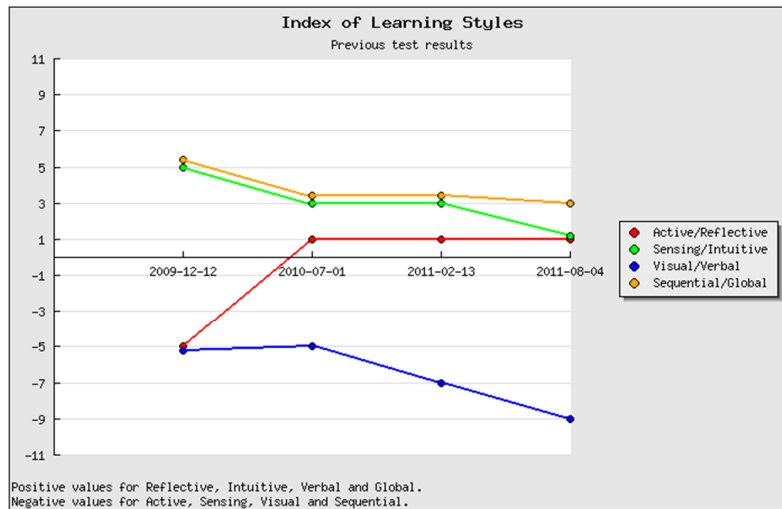
others have found the preferences more or less susceptible to change over time [Pri80], [Pin94].

4.2.3 Implementation of a web-based tool for defining learning styles

To determine and collect information about students' learning styles participating the courses at the department, the web-based standalone application *Learning Styles* was implemented under the supervision of the author of this thesis. The aim of this tool is to familiarize students with the existence of different learning styles, provide them a tool for determining their preferences and keep a record of the changes in their preferences if any such changes occur during their studies. After the information is collected, all of the pieces to combine it with teaching methods, soft skills and the students' educational results are there. They can be used to support the students in their choices when they make plans for their future career and select the appropriate courses to learn the required skills.

The platform is implemented to support multiple question sets, giving a possibility to complete divergent tests and obtain results using different methods and scales. Each registered user has his or her own personal account which can be used to access the results of completed tests later on. The results of the tests are stored in a database, which enables comparison of the previous results with each other. To observe if personal learning styles change over time, the tool records and stores each of the tests taken and provides the user with the possibility to track these possible changes. To prevent users from distorting the tests to match "desired results", the option of blocking the re-running of the test for a given period of time was included. As a good balance between the preferences is desirable, the student can follow if he or she has been able to influence his or her personal style and achieve a better balance over time. A screenshot of the results in a timescale of an individual student is presented in Figure 21.

Index of Learning Styles - Previous test results



#	Date	Active/Reflective	Sensing/Intuitive	Visual/Verbal	Sequential/Global
1	2009-12-12	-5 (active)	5 (intuitive)	-5 (visual)	5 (global)
2	2010-07-01	1 (reflective)	3 (intuitive)	-5 (visual)	3 (global)
3	2011-02-13	1 (reflective)	3 (intuitive)	-7 (visual)	3 (global)
4	2011-08-04	1 (reflective)	1 (intuitive)	-9 (visual)	3 (global)

Figure 21: Trend of a single student's results using the ILS test.

The platform is open for registration to anyone who wishes to use it. However, in order to be able to classify the users, some background information, such as the university, faculty and student ID, are requested. Although the results are anonymous to a certain extent, access can be granted to the teachers, who can then filter a summary of the results based on the university or faculty, or on the list of students participating in their courses. Exporting the results and examining them in groups or overlapping the results with e.g. grades is made possible. To guarantee the privacy of the users, their personal information is not shown to the teacher, and the results need to include at least five students to be shown. The administrator has the right to export the results for research purposes – such as to compare the learning styles to the grades. In such cases, the results are identified by using student IDs, which does not guarantee full anonymity.

4.2.4 Results

The results of preferred learning styles based on Felder and Silverman's model were analyzed for 129 students altogether between the years 2010 and 2012. Except for the distribution between sequential and global learners, the results follow the earlier findings concerning Finnish engineering students [Ala10], [Sav05]. A compilation of the results is presented in Table 18. The sample size is still rather limited, and the difference may be caused by the number of foreign students and volunteer participants in the test.

Table 18: Learning style preferences of the 129 respondents.

Preferred learning style	Number of respondents
Active	82
Reflective	47
Intuitive	85
Sensing	44
Visual	104
Verbal	25
Sequential	58
Global	71

A more detailed distribution of the selected students' learning styles is visualized in Figure 22.

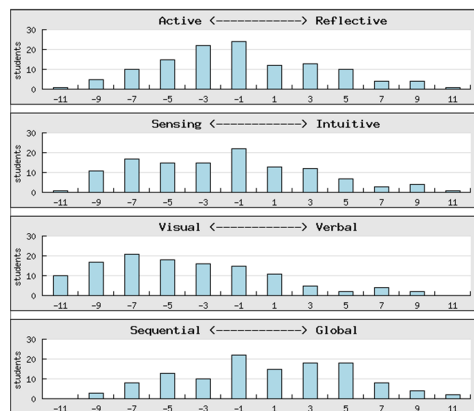


Figure 22: Students' learning styles on four scales.

Study records of the students who had completed the learning style test were accessed from the university student information system. In total, 7 542 course records for these students were found. Out of these results, 4 740 were final grades for courses passed (the earliest from the year 1987) and had been evaluated with a grade from 1 to 5.

The importance of learning preferences against their counterparts was analyzed by comparing the degrees of success of students in different sets of courses. The first test was completed for all the completed and graded courses of the students. Based on the independent samples T-test, it can be assumed that within the courses that these students have taken there has been an observable significance within the holders of some learning preferences (significance of t-test < 0.05). The sequential learners have received better grades than global learners, and reflective learners seem to have done slightly better than active learners. A summary of these results is presented in Table 19.

Table 19: Independent samples T-test for the results of all the passed courses given a grade.

	<i>N</i>	<i>Mean</i>	<i>Std. Deviation</i>	<i>S.E. Mean</i>	<i>Sig. (2-tailed)</i>
Active	2904	2.991	1.263	0.023	0.019
Reflective	1836	3.078	1.239	0.029	
Intuitive	3104	3.046	1.239	0.022	0.113
Sensing	1636	2.985	1.283	0.032	
Visual	3547	3.013	1.256	0.021	0.251
Verbal	1193	3.061	1.249	0.036	
Sequential	1909	3.118	1.257	0.029	0.000
Global	2831	2.962	1.249	0.235	

As the classification including all the completed courses displays an overview of the differences between learning styles, consideration of the results in smaller subsets is presumably more fruitful. Results for the courses organized by the Laboratory of Information processing between 2007 and 2009 are presented in Table 20. The sample size (254 completed courses) is relatively low, but the difference between some of the means is considerable. Based on the t-test, reflective students seem to have succeeded better than active students, and intuitive students succeeded much better than sensing students. Whether this is due to the content of the courses, to the teaching methods used within these courses or to another reason is not considered in this thesis, but in general, the results are consistent with the results considering all the completed courses.

Table 20: Independent samples T-test for the grades of courses organized by the Laboratory of Information Processing.

	<i>N</i>	<i>Mean</i>	<i>Std. Deviation</i>	<i>S.E. Mean</i>	<i>Sig. (2-tailed)</i>
Active	169	3.095	1.250	0.096	0.001
Reflective	85	3.624	1.058	0.115	
Intuitive	154	3.533	1.092	0.088	0.000
Sensing	100	2.870	1.284	0.128	
Visual	186	3.274	1.210	0.089	0.956
Verbal	68	3.265	1.229	0.149	
Sequential	107	3.383	1.113	0.108	0.202
Global	147	3.191	1.279	0.106	

A more detailed picture of the results among different learning styles can be given by selecting the courses based on the content. Table 21 presents the results of the students in mathematical courses (570 grades given). In this case, the only meaningful difference is between sequential and global learners. Not surprisingly, sequential learners, being more capable of gaining understanding in linear steps in general, seem to perform better in mathematics, whereas the other scales in Felder and Silverman's model do not seem to have that important effect.

Table 21: Independent samples T-test for the grades in mathematics courses.

	<i>N</i>	<i>Mean</i>	<i>Std. Deviation</i>	<i>S.E. Mean</i>	<i>Sig. (2-tailed)</i>
Active	350	2.494	1.381	0.074	0.149
Reflective	220	2.673	1.469	0.099	
Intuitive	376	2.572	1.418	0.073	0.839
Sensing	194	2.546	1.418	0.102	
Visual	422	2.555	1.428	0.070	0.803
Verbal	148	2.588	1.390	0.114	
Sequential	248	2.754	1.448	0.092	0.005
Global	322	2.416	1.377	0.077	

For a computer science student, programming is one of the fundamental skills covered in numerous courses. The results for this case are presented in Table 22. In contrast with the results of the courses organized by the Laboratory of Information Processing, sensing students seem to be graded better than intuitive students. Sensing learners are described to be more practical, to be more patient with details and to like learning facts more than intuitive learners. In mathematics, sequential learners also perform better than global ones, and reflective learners perform better than active ones.

Table 22: Independent samples T-test for the grades in programming courses.

	<i>N</i>	<i>Mean</i>	<i>Std. Deviation</i>	<i>S.E. Mean</i>	<i>Sig. (2-tailed)</i>
Active	306	3.186	1.268	0.073	0.003
Reflective	190	3.521	1.203	0.087	
Intuitive	179	3.095	1.344	0.100	0.003
Sensing	317	3.439	1.183	0.066	
Visual	365	3.293	1.279	0.067	0.511
Verbal	131	3.374	1.179	0.103	
Sequential	206	3.476	1.260	0.088	0.016
Global	290	3.200	1.237	0.073	

With the presented samples, only one of the pairs remains insignificant so far: visual versus verbal learners. The given grades for student bachelor's and master's theses are presented in Table 23. In this case, the significance between these two preferences is highlighted. As the written thesis is an important factor in evaluation, it likely that the delivery of the completed project in written words is more natural for verbal learners, who get more out of words, in both spoken and written form.

Table 23: Independent samples T-test for the grades awarded in Bachelor's and Master's thesis.

	<i>N</i>	<i>Mean</i>	<i>Std. Deviation</i>	<i>S.E. Mean</i>	<i>Sig. (2-tailed)</i>
Active	50	3.780	0.740	0.100	0.090
Reflective	29	3.410	0.980	0.180	
Intuitive	36	3.750	0.870	0.150	0.320
Sensing	43	3.560	0.830	0.150	
Visual	61	3.540	0.870	0.110	0.040
Verbal	18	4.000	0.690	0.160	
Sequential	27	3.440	0.890	0.170	0.130
Global	52	3.750	0.810	0.110	

The sample size of the collected learning styles and grades is too small to make statistical judgments for individual courses. Therefore, the results are presented only with a set of similar courses based on the content. However, the systematic use of a tool to collect students' learning styles and link them with learning results can provide valuable information both for the teacher who is giving the course and for the students who are participating in courses.

Classifying courses based on their content is a way to show if there are differences in the results between different learners. An examination of the results can also be based on a more in-depth look into the courses, the methods, or the skills that are involved. The results of these students were also examined based on the summary of teaching methods presented earlier in chapter 3.1 "The role of soft skills as a part of teaching" of this thesis and in *Publication 3*. Unfortunately, the gap between course evaluation and identification of learning styles resulted in only 446 courses having with a grade to analyze. Table 24 presents the students' performance in courses where different skills are required. For each of the groups, an average of the skill in question is calculated. Independent samples T-tests with a 95% confidence interval have been completed for these values to check if there are significant differences in evaluation between the learning style pairs. Since the sample sizes for single courses remain so small, differences cannot actually be proven, but some differences can still be highlighted. Supervision skills have been included in so few completed courses that results are negligible.

Table 24: Influence of learning style on performance in classes covering different social skills.

Learning style	Evaluated courses in the group of selected learning style		Leadership / Mgmt	Negotiation	Interaction	Team work	Supervision
Active	283	No. of courses taken including specific skill	50	35	57	73	3
		Grade mean	3.87	3.71	3.60	3.32	3.33
Reflective	163	No. of courses taken including specific skill	28	17	32	39	2
		Grade mean	3.64	3.80	3.50	2.95	3.00
Result (Active vs. Reflective)		T-test Sig-2 (Grade)	0.509	0.856	0.721	0.398	0.667
		Difference (Grade mean)	0.228	-0.094	0.100	0.372	0.333
Sensing	278	No. of courses taken including specific skill	41	28	50	55	2
		Grade mean	3.58	3.85	3.62	3.13	3.50
Intuitive	168	No. of courses taken including specific skill	37	24	39	57	3
		Grade mean	4.11	3.56	3.46	3.27	3.00
Result (Sensing vs. Intuitive)		T-test Sig-2 (Grade)	0.076	0.510	0.618	0.735	0.500
		Difference (Grade mean)	-0.528	0.291	0.161	-0.144	0.500
Visual	341	No. of courses taken including specific skill	60	40	68	80	4
		Grade mean	3.75	3.61	3.62	3.32	3.00
Verbal	105	No. of courses taken including specific skill	18	12	21	32	1
		Grade mean	4.00	4.25	3.31	2.79	4.00
Result (Visual vs. Verbal)		T-test Sig-2 (Grade)	0.532	0.250	0.358	0.280	N/A
		Difference (Grade mean)	-0.250	-0.639	0.315	0.532	-1.000
Sequential	180	No. of courses taken including specific skill	25	16	37	39	0
		Grade mean	3.53	3.63	3.43	2.95	0.00
Global	266	No. of courses taken including specific skill	53	36	52	73	5
		Grade mean	3.96	3.79	3.66	3.32	3.25
Result (Sequential vs. Global)		T-test Sig-2 (Grade)	0.184	0.722	0.406	0.398	N/A
		Difference (Grade mean)	-0.435	-0.161	-0.229	-0.372	N/A

Also, the correlation of participation in courses with these skills and different learners is evaluated. Table 25 presents the correlation between participation in different courses and different learners. One can detect the most meaningful differences between learners when comparing sensing versus intuitive learners and sequential versus global learners.

Table 25: Influence of learning style on participation in classes covering different social skills.

Learning style	Evaluated courses in the group of selected learning style		Leadership / Mgmt	Negotiation	Interaction	Team work	Supervision
Active	283	No. of courses taken including specific skill	50	35	57	73	3
		Amount of listed skills awarded for these courses	89	40.5	84.5	122.5	3
		Normalized frequency of skill per completed course	0.314	0.143	0.299	0.433	0.011
Reflective	163	No. of courses taken including specific skill	28	17	32	39	2
		Amount of listed skills awarded for these courses	44	21	53	51	2
		Normalized frequency of skill per completed course	0.270	0.129	0.325	0.313	0.012
Result (Active vs. Reflective)		T-test Sig-2 (Freq. of skill)	0.526	0.717	0.527	0.170	0.872
		Difference (Freq. of skill)	0.045	0.014	-0.027	0.120	-0.002
Sensing	278	No. of courses taken including specific skill	41	28	50	55	2
		Amount of listed skills awarded for these courses	67	32.5	71.5	83	2
		Normalized frequency of skill per completed course	0.241	0.117	0.257	0.299	0.007
Intuitive	168	No. of courses taken including specific skill	37	24	39	57	3
		Amount of listed skills awarded for these courses	66	29	66	90.5	3
		Normalized frequency of skill per completed course	0.393	0.173	0.393	0.539	0.018
Result (Sensing vs. Intuitive)		T-test Sig-2 (Freq. of skill)	0.041	0.150	0.041	0.002	0.352
		Difference (Freq. of skill)	-0.152	-0.056	-0.136	-0.240	-0.011
Visual	341	No. of courses taken including specific skill	60	40	68	80	4
		Amount of listed skills awarded for these courses	103	50	105	124.5	4
		Normalized frequency of skill per completed course	0.302	0.147	0.308	0.365	0.012
Verbal	105	No. of courses taken including specific skill	18	12	21	32	1
		Amount of listed skills awarded for these courses	30	11.5	32.5	49	1
		Normalized frequency of skill per completed course	0.286	0.110	0.310	0.467	0.010
Result (Visual vs. Verbal)		T-test Sig-2 (Freq. of skill)	0.838	0.661	0.838	0.161	0.852
		Difference (Freq. of skill)	0.016	0.037	-0.002	-0.102	0.002
Sequential	180	No. of courses taken including specific skill	25	16	37	39	0
		Amount of listed skills awarded for these courses	39	19	51	64	0
		Normalized frequency of skill per completed course	0.217	0.106	0.283	0.356	0.000
Global	266	No. of courses taken including specific skill	53	36	52	73	5
		Amount of listed skills awarded for these courses	94	42.5	86.5	109.5	5
		Normalized frequency of skill per completed course	0.353	0.160	0.325	0.412	0.019
Result (Sequential vs. Global)		T-test Sig-2 (Freq. of skill)	0.037	0.041	0.037	0.333	0.065
		Difference (Freq. of skill)	-0.137	-0.054	-0.042	-0.056	-0.019

Based on the results presented in Table 24 and Table 25, some differences are detected for participation and performance of the selected students in courses:

- There are no differences within the soft skills in the courses that active and reflective students have taken. Active students have participated more in courses including team work than have reflective students, but the difference is not meaningful.
- Intuitive learners have participated more in courses with leadership/management, interaction, and team work than have sensing learners. Intuitive learners' performance has been better in courses including leadership and management skills, but the significance is unproven with the test group.
- A significant difference between visual and verbal students in course participation was not detected.

- Global students have participated more in courses with leadership/management, negotiation and interaction skills than have sequential students. There have not been differences in global students' performance in these courses.

In the inspection of these results, there are a few issues that must not be forgotten, as they indeed affect the results. First of all, the sorting of the courses and course content is based on interviews which appeared in *Publication 3* reflecting the opinions of the teachers and interviewers. Secondly, some of the courses the major students have selected are mandatory; thus, participation in the course is not completely on a voluntary basis. Thirdly, teachers also have different methods of teaching which, if too unbalanced, may benefit some types of learners and hamper others, regardless of the course content.

The correlation between the style of learner and participation in different types of courses is a more complicated issue. There are even more variables that participation depends on. Selection of courses is often affected or even determined by a student's major. On the other hand, soft skills that are to be taught in courses often remain invisible to students at the moment of selecting the courses.

4.3 Discussion

Personal study planning has a role in both the developmental approach and the reflective approach to portfolio construction. When students use portfolios to document their achievements and artifacts, study plans act as a good foundation on which to build proof of skills to indicate personal knowledge on a larger scale. By collecting these pieces of information and subsequently comparing them with the development plan, students can follow their personal development and interconnect the once disparate pieces of information. The idea of incorporating personal study and development planning into portfolios becomes even more interesting and obvious when the relevance of courses is made more visible to students and the course selection is linked to their career goals, as Farzan et al. [Far10] have suggested. By adding the skills and knowledge already into the planning process, passing a course is not just a step towards graduation: it is a step towards expanding one's skills and experience on the trajectory to expertise.

In terms of constructing personal knowledge and skills, both personal development planning at the higher level and personal study planning at the execution level are important from educational and university perspectives. Although currently the personal study plan is not, in general, a binding contract between the institution and the student, it can still be used as a tool for controlling the student's progress. However, it should still remain as a learner-centric tool, serving students' needs. Consequently, personal study plans in many cases should no longer be formal lists of activities that fulfill the requirements for the degree; they should also support the student in his or her personal goals and ensure a more logical path and order of studies.

Alan Mumford has expressed his concern for how learning style information can be used to produce development solutions [Mum95]. He notes that the relationship between development needs, possible solutions in terms of development processes, and learning style preferences are fundamental to the production of an effective personal development plan. Actually, as students do have different learning styles, e-portfolios can be used to support this diversity by providing functions that serve the various

learning style needs of students. Portfolio construction requirements should not be provided only in a top-down manner and tied to one format. On the contrary, when students are given sufficient freedom for collecting, reflecting, and presenting results, they may be better motivated to use the tools as long as the advantages and eventual purpose(s) are clear.

Although the *Learning Styles* tool provides the opportunity for teachers to collect information from their students and for administration to compare student learning styles to course results, it must not be forgotten that the primary target group for the tool is the students themselves. In addition to following and becoming more aware of their personal characteristics and the development of their personal methods by using the tool regularly, students can use the information about themselves to support the decisions they make. Thus, the selection of the courses they take could be assisted as long as more precise information about the courses and teaching methods is available. Moreover, better self-knowledge might help when one makes career path plans and desires to know which types of jobs could be suitable and appropriate. Once again, information about the typical requirements of different types of jobs should be available to support decision-making.

Recognizing personal strengths in relation to an identified learning style affects the decisions students make regarding the courses they take. After obtaining more experience, students are likely to become aware of their personal learning methods even without taking any tests. However, at the beginning of one's studies when learning techniques are not necessarily developed yet, this information could be used to help make choices and to provide support on how to approach some of the courses that may require closer attention.

Not only the learning methods but also the teaching methods vary among different courses; the same exact course may have different versions with different teaching and learning methods. It would be naïve to expect all or even most teachers to balance their teaching methods, even if they had information concerning the performance of different learners in specific courses and the differences among the methods being used were arguable. Therefore, showing potential advantages or disadvantages between the personal preferences and performances of different learners earlier in these courses can be put into use when students are creating their learning plans for the courses.

The majority of the students in the research group of this thesis and of engineering students in Finland are active rather than reflective. However, taking a reflective approach to learning was shown to have a positive effect on learning technology. Improving the students' reflective side can give them a chance for better learning results, and it especially makes them stop and think about their achievements and skills they have learned. On the other hand, reflection also is vital from an e-portfolio perspective. One answer for starting to improve students' reflective side is to have them think about what they have done, and compare this to what their peers have done. The following chapter discusses peer review as a tool for leading students to self-evaluation and eventually reflection.

5 Identifying personal strengths through reflection

An important part of becoming a professional involves cognizance and recognition of personal capabilities and skills as well as the importance of these. An evaluation of one's capabilities can be attained from experience of working in the field, but since many students are not yet in a position to have had that experience, this evaluation could also be supported by the tools that have been presented earlier in this thesis. For students, especially in the case of less-experienced ones, the only source used to estimate their capabilities comes from the evaluation of the teachers in single courses. The term "self-assessment" is used for students' own evaluation of personal learning outcomes and achievements [Fal89].

Self-assessment, referring to the involvement of learners in evaluating their own performance, has a clear relation to reflection. According to Sober [Sob97], self-assessment and self-directed learning gives the tools and basis for reflection and is also important in helping students to learn and monitor their own performance [Slu99]. Although the university provides a transcript of completed courses, the students themselves are responsible for what they have learned, how they have improved their learning, how they maintain their skills, how they value their know-how, and how they put the skills into practice. As different learning models indicate, some learners have tendencies towards a reflective approach more than others. The ability to reflect is identified as one of the key skills for professional development [Fri01].

Peer assessment, or peer evaluation, is also linked to reflection. It is not merely a grading procedure or a way to reduce teachers' work; it is an aspect of the learning process which improves the students' skills. According to Sluijsmans [Slu99], peer assessment can be seen as a component of the self-assessment process, and it serves self-assessment by adding the contribution of other students as an input into the process. Providing an opportunity for peer reviewing offers two advantages: students have an opportunity to see and comment on others' solutions to a given task, and they receive more feedback on their solutions from their peers. When students have the possibility to examine peers' solutions, they are given tools to compare their own solutions to others'. This provides a baseline for the evaluation of one's own solutions and thus one's own skills.

Hazen et al. [Haz09] have stated that self-assessment can also be a valuable way to improve the learning process. Including reflection in the learning process can establish a starting point for better meta-cognition, engage the students in learning and thus enhance the learning process. Being a part of that process, reflection is also critical to e-portfolio implementation and construction, especially when the topics are more holistic and when a process-based approach to the construction of portfolios is taken. For example, Dorninger and Schrack [Dor07] have observed that an electronic portfolio

considerably supports reflective learning. Kimball [Kim05] has written that reflection undergirds the entire pedagogy of portfolios. It is the piece that is the reason for collecting artifacts into portfolios and the rationale by which the portfolio is constructed: to be able to reflect what has been done. This should encourage learners to be more self-critical and to honestly consider their achievements as compared to their goals.

The role of reflection in portfolio pedagogy, especially that concerning e-portfolios, is not always accorded enough attention. When collection, selection, and reflection activities are grouped together as if being on the same level, they are all too easily made to sound equal, although few see them as such [Kim05]. Collection is only a mechanical process, selection is more dynamic and requires more attention, but reflection actually forces learners to think about their learning and accomplishments. Without reflection, portfolios are easily relegated to the level of recordkeeping in data warehouses.

5.1 Peer reviewing as a tool to support reflection

A lack of awareness of one's personal skills as compared to others' is reasoned to be the primary reason for inaccurate self-assessment [Dun03]. Peer review is a process for evaluating one or more peers' work, and it is widely used in academia to evaluate others' contributions. The principles of peer reviewing are simple and adaptable to various contexts, and motives for its use derive from the observations that peer reviewing can, for example, boost learning outcomes and provide accurate results in estimating the quality of submissions. In the pursuit of higher quality teaching alongside the reality of growing class sizes, the promise of providing good results in an efficient way makes peer reviewing even more attractive.

Having students review others' tasks may result in additional feedback that can be used to improve solutions to problems. Moreover, students evaluating their peers' assignments have an opportunity to see and examine other types of solutions to the given problem and learn from those. Students find the opportunity to inspect peers' solutions interesting because they can obtain new ideas and learn analytical abilities from varying styles in solving problems [Die09]. Therefore, peer review brings another dimension to the evaluation and feedback students get from their tasks.

According to Cho et al. [Cho08], when teachers are considered as experts, it should be borne in mind that one well-known type of behavior experts exhibit is the tendency to underestimate the difficulty of tasks when completed by non-experts. Therefore, the feedback and comments that students receive from multiple peers may be even more valuable than that which they receive from the teacher, and much less costly from the point of view of educational resources. On the other hand, Sluijsmans et al. [Slu99] among others have experienced that the weakest students are not able to judge their peers correctly and tend to over-rate themselves.

Peer assessment can also be used to support the analytic evaluation and grading of student assignments. Students can evaluate others' tasks based on the given criteria or standards. This also prepares the students' abilities and skills, and the evaluations can be shared with peers to make them aware of how others look at their work. Kane and Lawler [Kan78] have reviewed three methods of peer assessment: peer nominations, peer ratings, and peer rankings. Peer nomination refers to choosing the best in the group based on particular characteristics. Peer rating refers to rating each of the tasks in the

group based on defined values. Peer ranking refers to placing all of the others in order based on given factors. In this thesis, peer rating, which has been seen as the most useful feedback method, is considered for assessment, and the rest are left beyond the scope of this thesis.

The same tendency of peer evaluation seems to recur in self-assessment. Falchikov and Boud [Fal89] have analyzed studies and found differences in students' abilities to rate themselves. Based on their findings, it seems that the weak students tend to over-rate themselves and the good students under-rate themselves. This is called the *Dunning-Kruger effect*. However, more experienced students are more qualified to rate themselves by default. Students in advanced courses appear to be more accurate in their evaluations than those in introductory courses. Therefore, peer reviewing and evaluation can be considered as skills that can be developed and supported.

Resources in education are often limited, and support for students by providing feedback on their tasks often remains low. From the peer reviewing point of view, a large number of students in a course can be turned into an advantage. To increase the reliability of the assessments, the number of assessors has to be increased. With one reviewer per task, the feedback and evaluation is not necessarily reliable and it cannot be compared to anything. With two reviewers, the reliability can be increased, but if their evaluations differ significantly, it is difficult to conclude which one is more valid. Having at least three evaluators for each assignment gives more arguments for comparison and allows conclusions to be drawn about the validity of evaluations.

5.1.1 Calibration of student evaluations

There are many earlier studies arguing for and against the correlation between students' and tutors' evaluations. Teachers have multiple ways of supporting the evaluation process and thus of giving better tools for development. Providing scoring rubrics for evaluation and dividing the evaluation criteria into segments instead of a single overall score helps the students to move from holistic to analytic scoring of work, taking various aspects into consideration, and it guarantees that the evaluation methods are equal with the ones used by tutors [Ham05], [Ros06]. Giving feedback to students about their self and peer assessments also helps them to evaluate and improve their assessment skills. Finally, requiring the students to complete evaluations will give them more experience and is likely to provide more accurate results after they gain enough experience.

However, since previous studies have brought up differences in quality of evaluation, the various methods of giving weights for the evaluations have been researched as a part of this thesis. Sluijsmans et al. [Slu99] have excluded the highest and the lowest peer assessment scores for each individual when calculating mean scores. Hamer et al. [Ham05] have introduced an automatic calibration algorithm where the calibration factor is calculated based on the difference between the grades assigned by the reviewer and averaged grades, thus emphasizing the consensus of the class. Pinkwart and Loll [Pin09] have proposed calculating weights by comparing the evaluations of each peer individually to teachers' evaluations. Replacing the teachers' evaluations in Pinkwart's model with those of students' was tested, and no remarkable difference was sustained, as remarked upon in *Publication 5*. However, using weights to correlate the evaluations is more suitable to meeting teachers' needs, while students mainly obtain slightly more accurate evaluations from their peers. The value of the feedback given does not

increase. However, the student can be shown how other students and the teacher have evaluated her or his work. This allows the student to compare his or her evaluation with that of others and gives a realistic view of the student's own evaluation and grading skills.

5.1.2 System requirements for a peer review application

When the web-based open-source paper submission and review system called *MyReview* for programming assignments was earlier tested [Häm09a], it became obvious that the features of the system for peer review in learning were insufficient and several improvements were needed. Therefore, a more detailed list of essential features before re-analyzing the existing applications for peer reviewing was needed. When the features that a peer reviewing system for programming courses should fulfill were discussed with three specialists teaching programming, the following requirements stood out:

- The system has to be a web-based standalone system which is supported by the most common web browsers and does not require any additional plug-ins to be installed. Technically an open-source solution is desirable to allow customization.
- The submissions and students must remain anonymous throughout the entire process, although teachers need to be able to find out the real identities of the users. This has been an earlier limitation in peer review systems [Ste06].
- Teachers also need to have full control over deciding who is/are reviewing whose task. In some cases, grouping reviewers evenly by the measured quality of their reviews may also be used to improve the quality and motivation of peer-reviewing [Hun09], [Søn09].
- The reviewer selection process has to be easy and efficient. This is an important feature concerning usability in courses with a large number of students.
- Multiple file uploading for a single assignment has to be supported. This especially concerns programming assignments, since they may require submitting several separate files.
- The peer review has to be completed in the system, and teachers need to have a tool for creating an evaluation form which supports different types of input fields, both textual and numerical.
- Statistics about the reviews, such as averages of evaluations and the time used for reviews, should be available to the teacher.
- To support and control the peer review process, the system has to support pre-defined deadlines for submission and evaluation.
- Support for code peer review features within the system is an advantage.

Different systems for managing user submissions for the purpose of student assessment have been introduced in *Publication 5. Peer Grader* (PG), a Java application [Geh01],

was introduced as the first web-based peer review system for submission and review. It has later been adopted for submitting and reviewing purposes in the *Expertiza* platform [Geh06] used for producing reusable learning objects. Another application, *PeerWise* [Den08], is a tool for students for responding to questionnaires created by their peers. In addition to answering, created questionnaires can also be evaluated and debated. Staff involvement is kept to a minimum as students are expected to be self-reliant in using the system. Pearce et al. [Pea09] and Søndergaard [Søn09] have utilized the peer review functions of *PRAZE* in their research. Students can submit different types of work, such as reports and multimedia content, individually or in groups to be reviewed, and the reviews can also be evaluated. Open-source based *iPeer* [Spi06] lacks the possibility to upload files for evaluation and was not studied any further. Another open-source system called *Aropä* [Ham07] is preferably offered as a hosted service and seems to contain most of the features required.

Some more comprehensive course or learning management systems also include peer reviewing activities, although according to Ku and Chang [Ku11], peer review has not been included as an assessment tool in currently available LMSs or e-portfolio platforms. However, Lykourantzou et al. [Lyk09] has described the use of *Moodle* as a platform for a peer review process in an introductory level e-learning course on web design. Ku and Chang [Ku11] have lately presented their design for an all-purpose e-portfolio system, *uFolio*. The system establishes three major components, *MyFolio* being the representative part of the system, *MyClass* being the component containing the common functions of LMS, and *MyLog* being a personal space for students.

5.1.3 Implementation of *MyPeerReview*

Each of the studied systems were found to have some disadvantages in terms of our requirements and evaluation of programming assignments sufficiently. Due to the limitations of the systems that existed in 2009, a new web-based open-source peer review system, *MyPeerReview*, was implemented based on the Drupal content management framework. The implemented module provides the functionality required to control the whole peer review process. The system also contains a simplified theme to provide a trimmed user interface containing only the necessary actions to successfully perform the steps of peer reviewing. Figure 23 presents a screenshot of the customized theme and a single page containing the student's currently active tasks from the courses attended. The system and its implementation are further discussed in *Publication 5*.



Figure 23: User interface of *MyPeerReview*, including the student's active tasks.

After *MyPeerReview* was implemented, Hundhausen et al. [Hun10] presented an interesting software tool called *OSBLE* (Online Studio-Based Learning Environment). It is especially tailored for use in pedagogical code reviews (PCR). The main use scenario involves five steps: creating an assignment, students submitting solutions, students performing online reviews, students performing face-to-face PCRs with a moderator, and students resubmitting the final solution based on PCR. The fourth step, which concentrates on PCR, is a process in which a team of three or four students led by a moderator go through segments of each other's programming tasks, check that code against the list of best coding practices, and discuss and log the issues that have arisen. Since its introduction, *OSBLE* has been developed further and currently it is referenced as a learning management system.

The *MyPeerReview* system was introduced in a web programming course during the 2009-2010 academic year. The application was piloted at the end of the course for returning weekly programming assignments and subsequently fully taken into use for reviewing the final project assignments. The experiences collected over the following years are discussed in the following section.

5.1.4 Results from the peer review processes

During the web programming course in 2009-2010, students used *MyPeerReview* for reviewing twice: first to familiarize themselves with peer reviewing and the application during the last of the seven exercises, and after that to review the final project assignment. The students were asked to evaluate their peers' tasks based on a list of criteria, giving an overall score for the tasks and providing feedback on the criterion areas. During the first year, students also wrote personal learning diaries throughout the course, but in the second year, this task was removed and replaced with increased peer review tasks throughout all of the exercises and again for the final project assignment. This change was completed to avoid increasing the course load too much and, on the other hand, to see the effect of introducing peer review on a larger scale for students. Also, the evaluation form was improved to better correspond to the evaluation criteria that were used by the teachers.

In this chapter, the results of peer review for the final project assignment from the years 2010 and 2011 are presented. The peer review process is described in more detail in *Publication 5*. Evaluation forms were used to steer the peer evaluation. It consisted of formative and summative assessments. Students were asked to give each other open feedback about various issues, such as the originality of the idea, usability, and the design and scalability of the layout. The fulfillment of technical requirements was evaluated, and the features were analytically scored. As a summary, an overall score was also given for the assignment.

The given peer evaluations concerning the overall grades corresponded to the teachers' evaluations in both years. Reliability between teachers' and students' evaluation in the year 2010 was acceptable (N=24, Cronbach's alpha = 0.721 and Pearson's correlation $r = 0.716$). Students' evaluations were clearly more generous than those of the teachers. In the year 2011, reliability was improved (N=22, Cronbach's alpha = 0.851 and Pearson's correlation $r = 0.766$). Figure 24 shows the overall peer grades compared to the teachers' evaluations from both years. The figures indicate that after using peer review throughout the whole course in 2011 and being provided with an improved evaluation form, although the evaluations relate only to the given overall grades, students are capable of evaluating others' assignments in line with teachers.

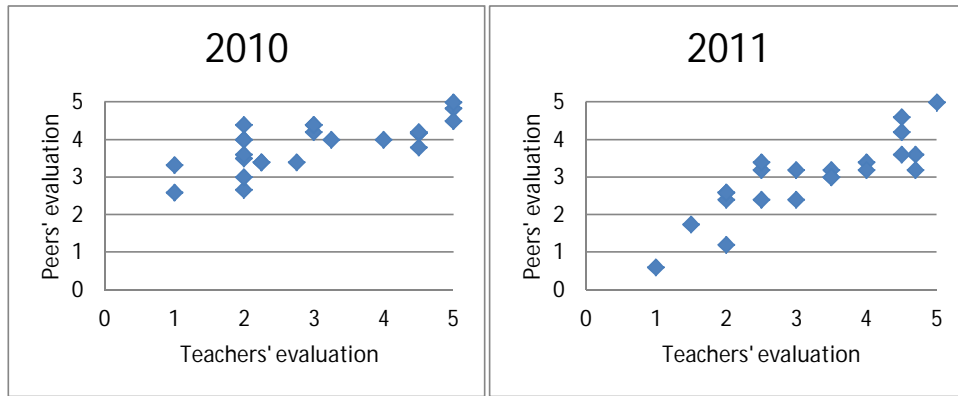


Figure 24: Correspondence between teachers' and peers' evaluations for assignments.

The correspondence between the quality of students' own submissions and the accuracy of their peer evaluations was also researched. To find out the accuracy of students' evaluations, Hamer's algorithm [Ham05] was used to calculate weights for each individual student's evaluations. The algorithm is used to calculate reliability for evaluators based on their evaluations as compared to others' for the same submissions. The more the evaluations are in line with each other, the better the weight is, in general. First, the differences between assigned and awarded grades were calculated for each student:

$$\Delta_r = \frac{\sum_{e \in R_r} (G_e - g_e^r)^2}{|R_r|} \quad (1)$$

Where

- G_e is the current grade for assignment e ;

- g_e^r is the grade assigned by reviewer r to assignment e ;
- R_r is the set of assignments allocated to reviewer r .

Then, an equivalent weight was calculated using the mean value of Δ_r :

$$W'_r = \frac{\text{mean } \Delta_r}{\Delta_r} \quad (2)$$

Finally the weights were controlled with a log function to guarantee reasonable behavior:

$$W_r = \begin{cases} 2 + \log(W'_r - 1) & \text{if } W'_r > 2 \\ W'_r & \text{if } W'_r \leq 2 \end{cases} \quad (3)$$

The results are presented in Figure 25. As can be seen, no correlation between the quality of evaluation (weight calculated using Hamer's algorithm) and the quality of the submission (grade given by the teachers) can be found. In 2010 (N=24), Cronbach's alpha was as low as -0.217, and Pearson's correlation -0.108. In 2011 (N=22), the correlation increased, but was still weak (Cronbach's alpha = 0.097, Pearson's correlation $r = 0.056$). Consequently, when looking only at the rating of the assignments, implementing a good-quality solution (not necessarily meaning that the students who completed bad-quality solutions are less skilled) does not automatically mean that the author is skilled as an evaluator. Based on this, using the scores from the implementation to calculate weights for evaluations should be carefully considered.

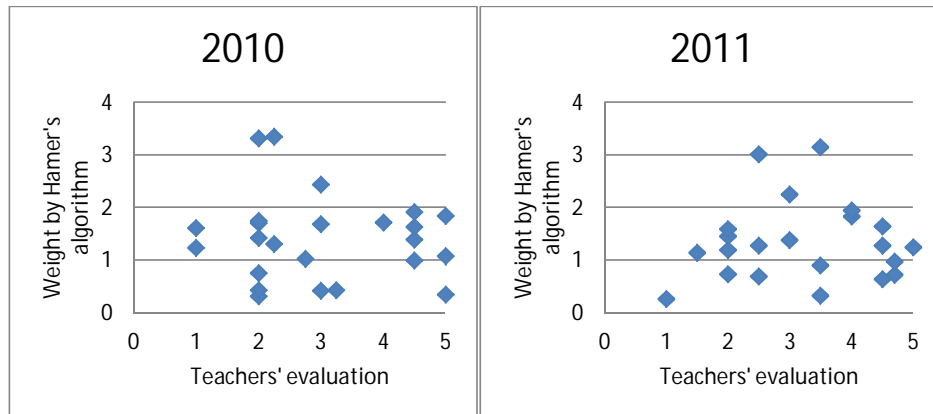


Figure 25: Correspondence between grade and peer evaluation quality using Hamer's algorithm.

A discrete analysis of features may be helpful for teachers in evaluation, mainly as a method of quick technical assessment of the submitted assignments. However, most of the students did not appreciate this approach very highly. They felt that whereas the evaluation concerning these features was fairly straightforward, they already knew whether the features were covered in their own implementation and the feedback from peer revision was useless. On the other hand, verifying the existence of these features had to be carefully inspected from the source code, requiring more effort for reviewing, which may also have caused some resistance towards the method.

From the departmental point of view, a more interesting and substantial question was how the students appreciated the feedback they received on their tasks from their peers. Upon deeper examination of the written feedback, the differences between students were notable. This was presumably because the quality of the feedback was not an evaluation criterion for the final course grade. However, even a handful of succinct comments from a single reviewer can help when combined with others' reviews. In terms of learning outcomes, the importance of properly explained textual responses with reasoned comments is clear. In the students' opinion, it was the most appreciated form of feedback in the peer reviews. Based on the results of the questionnaire, peer feedback was, however, not rated as valuable as teachers' feedback.

Although the students had no choice but to take part in the peer reviews concerning the final project, they reported that they had appreciated the opportunity to learn about a variety of different approaches from other students. A high level of participation in the voluntary evaluation of exercises and the positive feedback on the review process indicate that a majority of students did not consider the peer review too burdensome, although the level of commitment and quality of reviews varied.

There was one unintended consequence of adopting the peer review process for weekly programming assignments in the second year. The participation in the demonstration lectures, i.e. where a lecturer demonstrates how to solve a task or construct a solution, decreased dramatically from the previous year. The students, even the ones who were not capable of implementing the solutions by themselves, felt that through peer review they had already had the chance to become acquainted with the correct solutions. However, based on the logged times between accessing the solutions and sending the peer review forms, the time used for evaluation in many cases was remarkably short. This and the fact that the quality of reviews was often poor in these cases gave reason to suspect that the solutions were not properly examined and that the same level of familiarization of the topic was not reached compared to participation in demonstration lectures.

Peer reviews and feedback can be used to improve the weaknesses in solutions before final evaluation thereof. This has to be taken into account when planning the peer review process and the course schedule. Unless making the proposed changes to the solutions is made a requirement of the peer evaluation process, they probably will not be made. This, however, results in some questions. The quality of peer reviews will remain varying, which gives unequal opportunities for the students: those who receive good and extensive feedback have better chances to improve their solution. Naturally, this can be remedied by assigning a suitable number of peers for each student, which again creates a new challenge: if the solutions to be reviewed are too many, the quality and amount of feedback will eventually decrease.

Another problem is the students' tendency to finish their tasks only when it is obligatory. This could mean that, acting against their own good, students intentionally submit solutions that are unfinished for peer review. The solutions shared via peer review could be left unfinished to avoid helping the reviewers, who could adopt or plagiarize some parts of the assignment. Nevertheless, the peer feedback received in this case would probably end up being superficial, since there are more unfinished issues to comment on and the small but important improvements cannot even be taken into account. Using two evaluation rounds, the first for the peer reviewed solution and the second for the finalized one, and calculating the final grade for the assignment with

suitable weights could motivate the students to submit an appropriate solution already for the first evaluation round.

5.1.5 Results from the peer review processes to improve self-evaluation

As a consequence of the successful adoption and positive feedback of peer review in the teaching of programming, it was also included as a part of the final project assignment in the year 2012. Since the interest from the point of view of this thesis is whether the students are more qualified to recognize their own skills and competence after the peer review process, the emphasis from the research point of view shifted from the measurement of peer review quality to self-evaluation quality. This topic had been covered in the questionnaires of the previous years, but no valid control over the self-evaluation had been completed. Based on the earlier answers, most of the students had felt that the evaluations they received from their peers (and teachers) were valid. However, this did not indicate how the students had valued their own assignment both before and after the peer review process.

For research purposes, the peer review process was modified so that at the time of submitting their final project assignment, students were asked to complete an evaluation form. Students were asked to evaluate their solution, consider potential errors, the features that are missing, usability, and quality of the code. Finally, they were asked to evaluate the solutions based on the implemented features and to give an overall score. After all the students had submitted their solutions and evaluations, the peer review process was opened. This time the students were asked to evaluate only two peers to avoid increasing the load of the course too much. After the reviews were submitted, the peer review process was halted, and students were asked to complete self-evaluation again, based on the same form they had completed before the process was started. After the second round of self-evaluation was completed, the peer reviews were published for the students.

The effects of seeing others' solutions for the self-evaluation are presented in Table 26. Students' pre and post self-evaluations, the average of peers' evaluations, and average of teachers' evaluations on a scale of 0 to 5 are presented. Six out of 14 students evaluated their assignments differently in the second round; some of them increasing, others decreasing their grades. When one compares the differences between self-evaluations and teachers' evaluations, the average is remarkably close to 0. This shows again that although there are students that tend to overestimate or underestimate their solutions, in general the evaluations are in line with those of teachers in view of the grades of the whole class. When comparing the absolute difference of the pre and post self-evaluations compared to teachers' evaluations, the absolute difference between the grades decreases from 0.70 to 0.44, accomplishing an improvement of almost 40%.

Table 26: Effects of peer review process to self-evaluation in 2012.

<i>Student ID</i>	<i>Pre self-evaluation - Features</i>	<i>Pre self-evaluation - Overall grade</i>	<i>Post self-evaluation - Features</i>	<i>Post self-evaluation - Overall grade</i>	<i>Average of peer evaluation - Features</i>	<i>Average of peer evaluation - Overall grade</i>	<i>Teachers' evaluation</i>	<i>Difference between pre and post self-evaluation - Features</i>	<i>Difference between pre and post self-evaluation - Overall grade</i>	<i>Difference between pre self-evaluation and teachers' evaluation</i>	<i>Difference between post self-evaluation and teachers' evaluation</i>	<i>Absolute value of difference between pre self-evaluation and teachers' evaluation</i>	<i>Absolute value of difference between post self-evaluation and teachers' evaluation</i>
1	3	4	4	4	4.0	4.0	3.8	1	0	0.2	0.2	0.2	0.2
2	2	3	3	3	3.0	4.0	3.0	1	0	0.0	0.0	0.0	0.0
3	N/A	N/A	3	3	3.5	3.5	2.9	N/A	N/A	N/A	N/A	N/A	N/A
4	2	3	3	2	3.0	4.0	2.5	1	-1	0.5	-0.5	0.5	0.5
5	2	2	3	3	2.0	1.5	2.5	1	1	-0.5	0.5	0.5	0.5
6	4	5	5	5	3.5	4.0	4.0	1	0	1.0	1.0	1.0	1.0
7	5	4	5	4	4.5	4.5	4.0	0	0	0.0	0.0	0.0	0.0
8	2	3	2	2	1.5	2.5	1.5	0	-1	1.5	0.5	1.5	0.5
9	3	3	3	3	3.5	3.5	3.2	0	0	-0.2	-0.2	0.2	0.2
10	2	2	3	3	3.5	3.0	3.8	1	1	-1.8	-0.8	1.8	0.8
11	2	2	4	4	4.5	4.0	3.8	2	2	-1.8	0.2	1.8	0.2
12	4	4	3	3	4.0	3.5	3.5	-1	-1	0.5	-0.5	0.5	0.5
13	5	4	5	4	3.5	3.0	3.8	0	0	0.2	0.2	0.2	0.2
14	4	4	4	4	2.5	3.5	3.3	0	0	0.7	0.7	0.7	0.7
15	2	2	2	2	3.0	3.0	2.9	0	0	-0.9	-0.9	0.9	0.9
AVG	3.00	3.21	3.47	3.27	3.30	3.43	3.23	0.50	0.07	-0.04	0.03	0.70	0.44
MED	2.50	3.00	3.00	3.00	3.50	3.50	3.30						

The sample size (15) is relatively small for making accurate conclusions, but it does support the hypothesis that the peer review process not only supports the students with the increased amount of feedback, but also gives them better tools for recognizing the quality of their assignments, putting them on par with others' solutions and thus also leading to a more qualified evaluation of personal skills. Table 27 presents Pearson's correlation coefficient and Cronbach's alpha calculated for the collected reviews. As the first self-evaluation does not yet provide an impressive correlation with teachers' evaluation (Pearson's coefficient = 0.397, Cronbach's alpha = 0.474), peer evaluations are a step towards better correlation. This is followed by a significant improvement, when one compares the second round of self-evaluation to the teachers' evaluation (Pearson's coefficient = 0.790, Cronbach's alpha = 0.678). These evaluations

correspond to each other much better. Another issue is that self-evaluations are compared against the average grades given by two teachers.

Table 27: Pearson's correlation coefficient and Cronbach's alpha for the results.

Sample A	Sample B	Pearson's correlation coefficient	Cronbach's alpha
Teachers' evaluation	Pre self-evaluation	0.397	0.474
Teachers' evaluation	Average of peer evaluations	0.554	0.518
Teachers' evaluation	Post self-evaluation	0.790	0.678
Average of peer evaluations	Pre self-evaluation	0.476	0.406
Average of peer evaluations	Post self-evaluation	0.408	0.410

In addition to receiving support for reflection through becoming conscious about one's personal know-how compared to that of others' by comparing the quality of assignments, another concern is how the outputs from the peer review process can be used to support the content and artifacts in personal e-portfolios. The feedback, especially when positive, can be used to advertise personal achievements in learning. Also, the ability to carry out peer reviews could also be evidence of skills and proficiency in evaluation. It may be debatable to what extent potential employers appreciate this type of feedback and how creditable it is, but using these evaluations to support the evaluation of achievements can in turn be used to support reflection.

5.2 Online learning diaries

Before being able to take part in community-driven discourse, students typically need to have first developed a personal voice and sense of identity, according to Barton [Bar05]. After reaching this level, striving for consensus and learning to share a common, community voice becomes easier. Therefore, reflection, even in the form of keeping a learning diary, has a role in preparing students for expressing their opinions. This becomes necessary when students start to create reflections cooperatively. Barton [Bar05] writes, "Teaching and exposing students to blogging may be an excellent way of helping them acquire the subjectivity necessary for engagement in rational-critical debate." Making students think about the topics in more detail may reveal their personal areas of interests more deeply to them. Self-reflective consideration of topics can motivate students to explore their thoughts and feelings, develop their subjectivity, and value their own point of view more highly. Based on Habermas' [Hab91] work, Barton [Bar05] proposes starting with self-reflective blogging to help students to create subjectivity and to become acquainted with their own thoughts. This stage would be followed by the use of discussion boards to expose the students to critical debate, creating a need to present quality evidence to strengthen their arguments. At the final stage, after having gathered enough experience, students should be able to strive for consensus.

Safran [Saf08] has used blogging to influence students' learning performance. Based on the positive results from his experiments, he proposes using weblogs voluntarily to improve learning performance in the learning of programming. Although the activity in blogging can be used as a predictor for programming performance, it remains unclear

whether blogging improves performance or whether the better performers are simply more active.

Nückles et al. [Nüc06] have defined learning diaries as students' written reflections on their learning experiences and outcomes of their learning in courses. The writing of such diaries can be guided through the modeling and scaffolding of the phases of planning, production, and revision. Nückles et al. have implemented a computer program, eHELp, to support these steps in this reflective process, which should foster deeper processing and better retention of learning. The diaries are published, and learners can read and discuss their peers' diaries, which renders the learning diaries public documents.

When students are reflecting on their learning process, for many of them the challenge lies in how and upon what they should reflect. If the teacher interferes in and guides the reflections too much, he or she has had an influence on them. Furthermore, in the construction of a portfolio, if the reflection is left mainly to the teacher, it can easily become superficial and be based on limited evidence, according to Tartwijk et al. [Tar08]. On the other hand, if the reflection is completely on students' shoulders, the most superficial of the resulting reflections are only descriptions and summaries of events [Haf11]. This is not what reflections should be; instead, students should reflect on their own learning or compare given topics to personal experiences and expectations, and the reflection should involve an analysis and an application to future practice [Haf11]. Based on our pilots [Häm09b], more experienced students (including adult students) tend to be able to create more profound and relevant reflections than young freshmen. It is obvious that as most freshmen do not yet have experiences to reflect on, they need to make a greater effort concerning the topics and take more learning-based approaches.

The concept of wiki technology is to provide a common platform where all of the users are allowed to have more or less the same right to edit information collaboratively. For learning purposes, the wiki platform can be used as a substitute for a static web page, giving the students a chance to read and search for knowledge. Students can use a wiki for creating personal pages, such as learning diaries, but also use it as a collaborative tool into which they gather and structure information and thus improve their knowledge together.

5.2.1 Reflection using wiki-based learning diaries

A wiki platform has been used as a part of the Introduction Course on Telecommunications at LUT since the 2008-2009 academic year [Häm09b]. The course consists of lectures, homework, writing a learning diary, and a written exam, which are all evaluated. During the first year this concept was introduced, 70 students participated in the course, most of them first- or second-year Bachelor's level students.

Students were using wiki for their personal homework and for their personal learning diaries, which became public documents. As the wiki tasks focused more on collaborative aspects, composing and editing a common wikibook were also included into course requirements. The content of the diaries and the wikibook were evaluated by the teachers, and the best and most active students were given additional points for their efforts.

The students had been given a template for their personal page, where they wrote their reflections during the course. The template had suggested that the students, before the start of the course, write about their opinions and views about telecommunications in general. A list of a few keywords had also been requested. Each lecture had had an individual topic where the students were asked to write what they had learned and what they thought had been the message of the lecture. However, no examples were given.

The construction of the wikibook was only supported by providing a structure for the site, which was intended to help them to realize what type of content could be produced. By way of example, areas for abbreviations, terminology, questions and answers to exams held in previous years, bookmarks (links) to external topic-related websites, open questions, and finally, feedback, were created. With this categorization, students were given hints as to what could be collected. On the other hand, since they were neither experienced users of wikis nor experienced professionally, the assumption was that they probably did not have the confidence to modify the structure of the site.

5.2.2 Results

A good starting point for the successful adaptation of a wiki, whether for maintaining learning diaries or creating content in collaboration, is to provide extensive instructions and also support the production of the content. As many of the students may not be familiar with any wiki platform, some students may feel that learning the use of the wiki is an additional task in the course, and therefore their attitude towards it may be negative. The less experienced users are more likely to need some personal guidance in addition to the written instructions.

Based on the experiences from the course, maintaining a learning diary using a wiki did not turn out to be a functional solution. It did not provide significant benefits compared to other, probably more practical applications used for diaries, such as Blogs. An interesting finding based on the questionnaire the students responded to was that browsing through others' learning diaries was viewed as more useful than the creation of one's own. This may partly be a consequence of the lack of knowledge of what the students were supposed to write in their learning diaries and why. Therefore, other diaries were used for comparison and clarification of the task, and sometimes also as information sources. Thus, providing templates and a functional structure can help the students to realize what type of information might be produced. Templates and examples, especially concerning diaries, can better get the students on the right track in their tasks. Since this option was not considered when the questionnaire was submitted, the question remains unanswered.

When one examines the results and the end product of the wikibook, the abbreviations and terminology sections were the ones the students contributed to the most. Being that these sections were simple to add to (by copying and pasting) and did not require too much effort from students, this did not come as a surprise. Questions and answers from previous exams did not receive too much attention, but the page of potential questions for forthcoming exams had motivated students to update the list. Sending feedback or open questions to the teachers received moderate interest, especially compared to the amount of feedback and questions that lecturers receive through traditional forums, such as e-mails.

Although wikis are deemed as inherently democratic, history shows that “edit wars” can occur when users disagree about the content [Kit07]. In our case, none of the students had been editing the content created by others. Whenever some of the information in the wikibook was poorly written or incorrect, it was not edited, but instead other versions or descriptions were attached adjacent to the original one. Rather than adding comments and explanations, students should be encouraged to compile texts together or modify existing ones produced by others if they need correction.

From the students’ perspective, the wikibook has potential to be useful, even among inexperienced users. When the course participants were surveyed (43 out of 70 responded), it became obvious that the content produced in the wiki had served a purpose. Over half of the respondents had been using the wiki to prepare for the exam (or were planning to, since some of the respondents took part in the written exam held after the survey). Terminology and abbreviations were seen as the most useful (nearly 60% evaluated them as either useful or very useful) part of the wiki during the course. The part including questions and answers from previous exams was seen the second most useful (nearly 50% evaluated them as either useful or very useful), whereas the open questions (FAQ) were the least useful (less than 35% found them either useful or very useful). What was promising was that 42% of the students were planning to use the material in the wiki site later on for their studies. This leads to the conclusion that there should be a practical way to export the information to the students.

Since the experiences of the personal learning diaries and wikibook were positive, the same approach has been taken in the introduction course annually after its first introduction. Since the course is the first ICT-related course in the university for most of the students in the telecommunications software laboratory, writing a personal learning diary can be useful in terms of including reflection into the learning process directly at the beginning of studies.

The community and cooperative aspect supported by the use of wikis has been adopted in many other courses in which the author has been involved. For example, this aspect has been emphasized in the group work of code camp courses where the sharing of project ideas and documentation, useful links, and parts of code to solve common problems takes place [Hei08]; and in the creation of grounds for group discussions in seminar courses [Hap09]. The challenges that have been experienced are related more to the learning methods of the students than to the technical challenges of the platform.

5.3 Discussion

The role of reflection in the learning process and thus in the construction of an e-portfolio is fundamental. Drechsler [Dre11] places reflection in the middle and describes it as the heart of the e-portfolio, as presented in Figure 26. Falchikov and Boud [Fal89] have stated that lifelong learning requires individuals to be able to assess their own performance and progress, not only to work independently. As the more experienced students and those who have real-life work experience do not necessarily have as many problems concerning reflection as the inexperienced ones do, how the reflection process can be supported has to be considered. Providing more exact information to students about the learning outcomes of the course involving soft skills and about the requirements of industry related to the topic is hopefully a solution that can be used to support the reflection process. Although this does not correspond to the

learning that has already taken place, it indicates some of the expectations that students should be able to meet and reflect on.

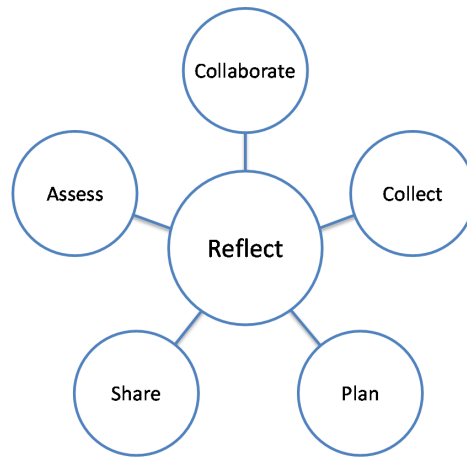


Figure 26: Reflection at the heart of e-portfolio.

Students reflect on their accomplishments as compared to the goals that they have set for themselves, but also on the accomplishments and the level of other students. It is arguable whether a student should first have the skills to perform self-evaluation before completing any peer reviews, but in any case, peer reviewing can also be used to develop students' self-evaluation competence. On the way towards developing self-evaluation, at some point one has to be able to compare one's achievements using a comparable scale. Being able to see others' solution and compare one's own achievements to them, as well as receiving feedback from peers who have more or less had the same basis for carrying out the task can give the student an even better view of his or her achievements.

Although e-portfolios are praised for including reflection as a fundamental component, it should be borne in mind that they do not automatically teach students to be reflective in practice. Students need to develop their understanding of the reflective practice themselves, and they need to be guided in their development of this ability in order to include it in their learning process and by extension, in their e-portfolios [Moo10]. Just as evaluation forms have been used to support the peer review process and bring out important details from the assignments evaluated, assessment rubrics can be used to support reflection activities.

The importance of peer review in supporting reflection has been recognized earlier [Lai06], [Ku11]. As an interactive assessment method, it enhances student interpretation and reflection. Peer review also works in supporting the entire learning process. Communicating with others about tasks can improve one's reflection skills, and the outcomes can also be used to improve the artifacts that are being produced and to gain a better understanding of one's own work [Han11]. Collaborative aspects can also be applied to improve students' reflective and critical thinking skills.

As the preliminary results of adding self-evaluation to the peer review process show, evaluating others' solutions supports one's self-evaluation by giving a better picture of the overall quality of the solutions from peers. In addition, what is even more important

about reflective thinking is that students are made to evaluate their own accomplishments and to think about what could have been improved. This is also a feature that makes students reflect on their competencies.

In the peer review assignments executed, reflection and evaluation are highly related to achievements and the ability to demonstrate one's know-how by implementing solutions. Since the students' technical skills are only one of the factors affecting the result (among the time used and diligence, tools being used, etc.), reflection can also be used to improve critical thinking skills. A large step towards reflection is the experience and feelings that one has gained from the learning process. Therefore, the students were required to keep personal learning diaries – to reflect on their learning in terms of their goals and expectations. As the resulting experiences pointed out, guidance must be taken into account concerning what a learning diary is and how it should be written to reflect on one's learning; its purpose is not only to sum up the teaching and lecture slides. Typically, this is much easier and more natural for adult students who already have some real-life experiences upon which to reflect their learning. Including these aspects in the reflection of less experienced students requires more attention. When one is able to keep a personal learning diary, the step taken to incorporate the reflection in the management of an e-portfolio is not necessarily a large one.

6 The potential of digitizing portfolios

The previous chapters of this thesis have introduced the implemented software applications that have a supportive role in the construction process of portfolios. Typical actions, such as planning, assessing, reflecting and even collaborating have been brought up earlier. Although the goal of this thesis is to show the importance of web-based software tools in gaining better skills and more knowledge to support the construction of an e-portfolio, the continuing role of e-portfolios of presenting personal achievements and following through of the later phases is important. Thus, collecting and sharing activities are worth discussing.

The shift from paper-based portfolios to electronic portfolios does not only affect how information is stored and presented; the ability to store digital artifacts provides much broader possibilities for the use of portfolios also from the representational aspect. An extensive, well-documented, and well-organized portfolio enables students to formulate individual, case-specific views of the large amount of data and choose only the relevant artifacts. Also, the ability to specify the artifacts semantically, link them to each other in different ways, and master them dynamically will help users when it is time to create a presentation portfolio for specific needs.

The importance of e-portfolios in the recruitment process cannot be ignored. Different types of artifacts and views from the same data are frequently used for different purposes and needs. In the case of one's applying for an ICT job, it may be important to be able to represent the programming code in some cases, design principles in others, and the user interface in still others.

Transferability is of significant importance in e-portfolios used to support lifelong learning, career planning and professional life later. From the technological perspective, there are still challenges, and a great deal of development is required. As an example, exporting and importing e-portfolios from one system to another is still quite limited in feasibility.

6.1 Role of showcase e-portfolios in the recruitment process

For many of the students who start to construct their portfolios for the first time, the eventual goal is to have an extensive portfolio that can be used to prove personal achievements and skills gained from education. Convincing students about the usefulness and potential of the outcomes of a showcase portfolio can be one method for motivating students to manage the artifacts and also to complete the stages in the construction cycle.

Earlier, more visual occupational groups, such as architects, artists, and models, have advertised their value using portfolios. Due to the digital revolution, however, portfolios

are now frequently also compiled by specialists from other areas, such as engineers. Not unexpectedly, most achievements, especially those of computer science students, are already by default in digital form. This offers a good basis for urging the students to collect artifacts systematically and at the same time promote the other supporting actions in the e-portfolio construction process.

Industry has also begun to pay more attention to portfolios. As late as 2005, Leece [Lee05] conducted a survey among employers in Australia about the use of e-portfolios in their graduate recruitment process. The results indicate that employers are not necessarily receptive to online presentations, and the benefits of e-portfolios need to be communicated to them.

Another study three years later by Gheris et al. [Ghe08] reported that the business, government, and educational institution recruiters that were interviewed preferred e-portfolios containing the following features: résumés, descriptions of employment experiences, descriptions of internship experiences, and references. Based on these results, recruiters cannot be said to have highly appreciated the opportunities that e-portfolios provide. Instead, what they seem to have wanted are applications resembling and containing the same information as the earlier applications, but now in a new format. However, at least accepting electronic applications through e-portfolio web services is a step towards understanding the higher value that can be realized from them.

Even currently, the importance and exploitation of e-portfolios for recruitment processes on a larger scale remain unclear. Strohmeier [Str10] has carried out a survey on studies and critically examined the importance and role of e-portfolios to find out if e-portfolios are suitable tools for recruitment. His conclusion was that the empirical studies are few and the existing results are opposing to each other: from advertising them as particularly suitable [Bra07] to condemning them as obviously impractical [Bra08]. Strohmeier points out that the e-portfolios should be understood as an ambivalent concept, but there are still several organizational and technical measures that could in the future improve their usage in recruitment.

The findings of Dinan-Thompson [Din10] support the idea of using the concept of e-portfolios not only for learning, but also for employment purposes. However, Dinan-Thompson also identifies the need for greater compatibility between the design of the e-portfolio and current employment interview guidelines and processes.

The value of the portfolio in representational terms often comes up at the end of studies or after graduation. In the future, one of the important features of e-portfolios will still be their use for representational purposes while looking for a job. The success and use of LinkedIn¹⁷ (already used for endorsing users by the connections of their skills) in recruitment shows that there is interest in a service that can be used to represent personal information and achievements in a concept broader than traditional CVs. Therefore, the portfolio is not to be discarded at the time of graduation only because universities often revoke access to their self-hosted systems. In contrast, external service providers will most likely offer continued access to the service only in exchange for a fee. However, if, for example, the service was hosted by the university, there has to be a way to export the portfolio and import it into another platform. This not only enables the use of e-portfolios for presentation purposes, but also for collecting experiences that are

¹⁷ <http://www.linkedin.com/>

gained in the world of work, leading to career portfolios and supporting lifelong learning.

6.2 Piloting the implemented applications with Mahara

To test the applications that were implemented and earlier presented in this thesis to support the process of constructing a personal e-portfolio, a pilot with 12 volunteer users was completed using the Mahara platform during April 2012. The applications introduced in this thesis were used to produce information, and the information was subsequently imported into the platform for different purposes for the e-portfolios of each test user.

The participants were asked to send their personal study plans, including the completed and scheduled courses. Based on the plan, a structure for the plan and course pages were created for all of these courses. Course descriptions were automatically retrieved from the university web site, a folder was created for course files, and a scheduling plan was added. A template was provided to introduce the possibilities of where the platform could be used when considering only single courses, not even the whole process of constructing an e-portfolio. In the designed purpose, users would start collecting the artifacts freely for each of these course pages. A sample of a student's course view based on the created template is presented in Figure 27.

CT60A4301 Tietokannat

Course description

Tavoitteet: Antaa opiskelijalle perustiedot suunnitella ja mallintaa relaatiotietokanta. Opiskelija oppii ymmärtämään olotietokantojen suunnitteluprosessia ja mallinnusta. Opiskelija oppii ymmärtämään asioita käsitteellisesti tasolla. Opiskelija oppii rakentamaan tietokannan erilaisiin käyttöjärjestelmäympäristöihin. Opiskelija oppii SQL-kielen perusteet.

Sisältö: Tietokantajärjestelmät. Tietokantojen suunnittelu. Olokeskeinen mallinnus ja ER-mallinnus. Relatiomallin tarkennus. SQL-tietokantakieli ja olokeskeiset kyselykielet (SQL3, OOL, upotettu SQL). Tietokantasuunnittelun näkökulma: kuinka tietokanta suunnitellaan, kuinka tietoa mallinnetaan, mitkä ovat tiedon tallennusrakenteet ja saarimenneimet, tietokäsit ja niiden yhteydet. ER-kaavioiden muuttaminen relaatiomalliksi ja relaatiotietokannaksi. Olomallien muuttaminen relaatiomalliksi. Eri tiedostotyyppien merkitys ja käyttö eri tietokantaympäristössä. Tietokantaohjelmoinnin näkökulma: kyselyiden ja muiden tietokantaoperaatioiden esitys, tietokannan hallintajärjestelmien palvelut ja niiden käyttö, esim. tapahtumat ja laukaisimet. Tietokannan toteuttaminen: miten tietokanta rakennetaan, miten tietokannan hallintajärjestelmää käytetään.

Saostustavat: Luentoja 14 h, harjoituksia 14 h, 1. periodi. Luentoja 14 h, harjoituksia 14 h, 2. periodi. Harjoitustyö 20 h, 1-2. periodi. SQL-verkkokurssin suorittaminen 40 h, 1-2. periodi. Tenttiin valmistautuminen 11 h ja tentti 3 h. Kokonaismitoitus 130 h.

Arviointi: 0-5, tentti 100%. SQL-verkkokurssi, harjoitustyö. Tai hyväksyty - hylätty, laaja SQL-verkkokurssi 100%. Harjoitustyö.

Oppimateriaalit: McFadden, F.R., Hoffer, J.A., Prescott, M.B.: Modern Database Management, Addison-Wesley, 5th Edition, 1999. Date, C.J.: An Introduction to Database Systems, Addison-Wesley, 2000. Connolly, T.M., Begg, C.E.: Database Systems, Addison-Wesley, 1999. Ullman, J.D., Widom, J.: A First Course in Database Systems, Prentice Hall, 2002.

Estiöt: Muiden kuin tietotekniikan koulutusohjelmien opiskelijoilta suoritettuna ennen tenttimistä CS30A0100 Johdatus tietotekniikkaan ja toimisto-ohjelmiin. Suositellaan CT50A2310 Tietorakenteet ja algoritmit (Data structures and algorithms).

Huomautukset: Opintojaksolla on 1-5 opiskelupaikkaa avoimen yliopiston opiskelijoille. Lisätietoja avoimen yliopiston WWW-sivuilta.

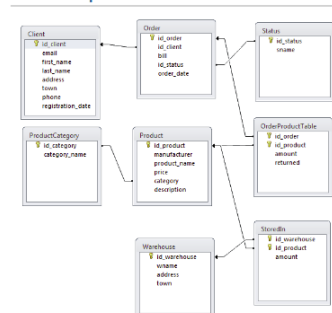
My goals for this course

Learning SQL, creating database with interface and advanced scripting using VB.

User interface for the Access database



Relationships



File(s) to Download

report.pdf
223.5KB | Tuesday, 01 May 2012 | Details

Tags: Database, ER, käyttöjärjestelmäympäristö, kyselykieli, mallinnus, olokeskeinen, olotietokanta, OOL, relatiomalli, relaatiotietokanta, SQL, SQL3, suunnitteluprosessi, tietokanta

Figure 27: An empty sample view for collecting information of a single course.

Course descriptions were not solely added to remind the users of and describe the course content and to function as a repository for the description; another of the goals was to use the descriptions to automatically pick up keywords from the descriptions.

The keywords were identified based on the mostly ICT terminology that *JobSkillSearcher* provides. The terms identified were automatically added to tag these views, which helps in searching and linking the related content. The tags that were identified from one of the course descriptions can be detected from the bottom of Figure 27. On average, 1.6 keywords were automatically recognized from each course description. However, for more than half of the courses, not a single term was recognized. This was partly due to the fact that among the test subjects were students from other departments who had not completed many IT courses, and that the IT students had their minors listed among the courses. On the other hand, obligatory general studies, such as mathematics and physics, did not contain any terms that would have been recognized. Also, based on the review by the author of the thesis, many of the descriptions of information technology department courses of past years could have been improved.

Mahara contains a function which lists the individual user's tags that can be used to help search for information. Users can freely tag the contents of their e-portfolio, but the automatic recognition of terms can be used on categorization. On average, more than 90 keywords were recognized from student e-portfolios automatically after the course descriptions based on the student personal study plans were added. A screenshot of a user's tags created automatically from course descriptions based on the *JobSkillSearcher* terminology is presented in Figure 28. An alphabetically sorted list of all the keywords in the complete e-portfolio is on the left; a more compact list is on the right. The list of relevant keywords provides the user with a chance to obtain a quick overview at the skills and topics he or she has gathered over the years and access them easily. Support for creating a CV and writing a job application can be offered not only by providing reminders but also by providing a way to access the collections of topics and potential artifacts as evidence that the user has stored in the personal e-portfolio.

The screenshot shows the 'My Tags' interface. At the top, there are two tabs: 'Sort tags alphabetically' (selected) and 'Sort tags by frequency'. Below the tabs is a long list of tags, including: aktiivinen (2), aktiivista (2), analogiset verkot (1), C (3), C++ (1), CGI (1), communication (1), CSS (1), Database (1), development (1), digitaaliset verkot (1), dynaamista (1), Finland (1), Helsinki (1), HTML (1), ILS (1), Internet (1), Java (1), JavaScript (2), johtamiseen (1), johtamisen (1), käyttöjäljättöisyys (1), kirjoitustaitoa (1), learning method (1), learning style (1), learning styles (1), matkapuhelinverkko (1), Mobile (1), monimedia (1), monimediaiverkosto (1), motivoitunut (1), multimedia (1), neuvottelutilanne (1), ohjelmoida (1), ohjelmointi (6), ohjelmointikieli (1), olo-ohjelmointi (1), ongelmanratkaisu (4), ongelmanratkaisutaito (1), organisointi (1), palomuuuri (1), Perl (1), PHP (1), programming (4), Python (1), radiolien ongelma (1), ruotsi (2), sisällöntuotanto (2), skills (1), software (2), sosiaalinen (1), soveltaminen (6), SQL-kielen (1), suomi (4), TOPIIP (1), testaus (2), tietokanta (3), tietoturva (1), trunking (1), Unix (1), verkkosivujen suunnittelu (1), verkkosivujen toteutus (1), verkkosuunnittelu (1), virus (1), vuorovaikutteinen (1), vuorovaikutustilanne (1), web (3), web-sovellus (2), WWW (1).

Below the tags list is a section titled 'Search results for All Tags'. It shows a table with columns for 'Sort results by: Name | Date' and 'Filter results by: All | Files | Images | Text | Pages'. The table contains four entries, each with a checkbox, a title, a description, tags, and a date/time stamp.

On the right side of the interface, there is a 'Tags' section with a compact list of tags: aktiivinen, C, JavaScript, learning method, tietokanta, motivoitunut, ohjelmointi, Ohjelmienratkaisu, programming, sisällöntuotanto, software, soveltaminen, suomi, testaus, ruotsi, web. Below this is a 'Search My Portfolio' search bar.

Figure 28: ICT keywords automatically picked up from course descriptions of an individual student.

Additional information of the completed courses was provided by sharing the available information of the teaching methods of courses and of the personal and social skills that are practiced during courses. Although the course contents may change from year to year, for this pilot the information collected during the year 2005, discussed in Chapter 3.1 of this thesis, and presented in *Publication 3* was used. Since many new courses

have been created and some of the courses have subsequently been replaced with new ones, not all the courses that students had already completed and included in their personal study plans were possible to take into account. However, a summary of the information was provided for the test users, and a sample view is presented in Figure 29. In addition, an average of all the courses in the program as well as average of values concerning other students' study plans was provided to give the students a chance to compare their values to the mean value of all the students.

My learning methods

Courses that you have completed

Course	Contact Teaching				Support Methods						Personal skills and knowledge						Social skills											
	LE	DE	SE	EX	PR	QU	RW	VI	HW	HE	HX	ES	CR	PS	WP	EV	PR	LA	PW	PG	ME	DS	LE	NE	IN	TW	SW	
Tilastomatematiikka I	3		2	1					2	1												2	1					
Lineaarinen Optimoiti	3		2	1					2	2			3	1								2	2				1	
Numeerinen Analyysi	2		2				1		2	1			3	1				1	1	1		3	2				1	
Matematiikka TIB1,2,3	2		2						1				2	3								2						
TCP/IP	3		2	1	1					2					1												1	
Monimedialinen Jakelukanavat	3						1						2															
Tietoliikennetekniikan harjoitustyöt					3							1	1	2									2	1		1		
Tietoliikennetekniikan seminaari	1	3							3			1	3			2	3	1					1		3	1		
Tietoliikennetekniikan perusteet	3					2			1				1						1									
Tietokoneverkot ja datansiirto	3																											
Tietorakenteet ja algoritmit	3		2					2	1	2			1	3		2			1	1	2					1		
Tietojenkäsittelyn perusteet 1	3		3					1	1	2			2	1	2			1	1	1		1	1	1	1	2	1	
Tietojenkäsittelyn perusteet 2	3		3					1	1	2			2	1	2			1	1	1		1	1	1	1	2	1	
Ohjelmointi B	1	2	2					1	2				1	1								1	2	1	1			
Ohjelmointi A	1	2	2					2	3	3			1	1								1	2	1	1			
Tietotekniikan perusteet	2		2					2	1				1									1	1					
Your normalized sum	2,3	0,3	0,2	1,5	0,4	0,2	0,1	0,6	1,3	0,9	0	0,1	0,9	1,2	0,6	0,3	0,3	0,4	0,4	0,4	0,8	0,6	0,3	0,2	0,5	0,4	0,0	
University provides (AVG)	1,9	0,1	0,3	1,4	0,3	0,1	0,1	0,3	1,1	1,1	0,3	0,1	1,1	1,5	0,8	0,4	0,4	1	0,6	0,8	1,1	0,9	0,4	0,3	0,4	0,6	0,1	
Other students completed	2,0	0,2	0,1	1,4	0,5	0,2	0,0	0,4	1,3	0,9	0,1	0,0	1,1	1,3	1,0	0,5	0,4	0,9	0,8	1,0	1,0	1,1	0,6	0,4	0,2	0,8	0,2	

LE Lectures
DE Demonstrations
SE Seminars

Figure 29: Teaching methods and personal skills being required in the completed courses of an individual student.

The students' results from the ILS learning styles test were also imported into the system in a single view. To offer the possibility to compare the results to others', average values of the 130 current results in the application database were provided. To give a better description of the results and tools to improve potential personal weaknesses, instructions for how to develop each of the measured parts in the test and a section for reflection were provided in the template. The layout of the template and single results are presented in Figure 30.

Learning styles

This view is a collection of your learning styles. The results of ILS tests were imported from the "Learning Styles" webtool if you have the test completed there. You can add your own reflection and collect other tests in this view.

My ILS results

Active / Reflective

You are **reflective** learner with value 1. (Respondents in average are active with value -0,86.)

Sensing / Intuitive

You are an **intuitive** learner with value 1. (Respondents in average are sensing with value -1,74.)

Visual / Verbal

You are a **visual** learner with value -9. (Respondents in average are visual with value -3,99.)

Sequential / Global

You are a **global** learner with value 3. (Respondents in average are global with value 0,70.)

Description for learning styles

Active and reflective learners

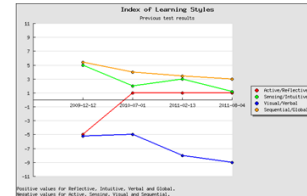
How can active learners help themselves?

If you are an active learner in a class that allows little or no class time for discussion or problem-solving activities, you should try to compensate for these lacks when you study. Study in a group in which the members take turns explaining different topics to each other. Work with others to guess what you will be asked on the next test and figure out how you will answer. You will always retain information better if you find ways to do something with it.

How can reflective learners help themselves?

If you are a reflective learner in a class that allows little or no class time for thinking about new information, you should try to compensate for this lack when you study. Don't simply read or memorize the material; stop periodically to review what you have read and to think of possible questions or applications. You might find it helpful to write short summaries of readings or class notes in your own words. Doing so may take extra time but will enable you to retain the material more effectively.

My ILS history



Reflection

You can e.g. reflect the results of your tests.

Figure 30: Results of learning style types imported into an e-portfolio.

At the beginning of the pilot, students were asked to create one job application, and at the end of the pilot, they were asked to submit two additional job applications for selected job positions. The advertisements selected for the pilot were authentic, but a pre-selection was done to find suitable jobs that the applicants really would have competencies for and also to guarantee that the requirements vary, to avoid targeting the advertisements for only one kind of student, such as programming-oriented ones. In between, they were asked to construct a real personal showcase e-portfolio using the structure that was automatically generated and presented in this chapter. When writing the last two applications, they were instructed to use the personal e-portfolios that they had created and also *JobSkillSearcher* application to get a better picture of the requirements that the types of jobs to be applied for typically have.

In this pilot, peer review had no role. As peer review in this thesis is mainly introduced as a tool to improve the abilities to recognize and evaluate personal skills and competencies better by having students evaluate the works of their peers in single courses, including it in this pilot was not essential. The role that could have been given for peer review in this short and restricted pilot would have been to have the students evaluate a selection of each others' portfolios. Presumably the same as what had happened with the programming assignments would have applied: the greatest advantage of the peer reviewing of portfolios would have been the adoption of the good aspects from others' portfolios, and only then the effect of potentially received feedback. As this thesis takes the approach that the e-portfolio is a very personal and learner-centric tool, introducing the peer review for e-portfolios on an involuntary basis would have only served to work against it. Students are competing against each other in applying for a job more so than in courses. Therefore, the general attitude towards sharing personal skills with peers is likely to be negative.

6.3 Integration and interoperability

Since the learning and production of the artifacts will take place using tools external to the e-portfolio platform, the interoperability of the tools and the transferability of artifacts will play a major role when e-portfolios serve as a platform for collecting and combining those artifacts. The information has to be made available from that platform. The importance is at least as high when the portfolios are being exchanged between different e-portfolio systems.

Particularly in computer science, the learning outcomes and achievements are often presented as files. When artifacts are only processed at the level of separate files, transferring them between systems does not require advanced specifications for the content. However, right after the files are described with additional metadata linked to other entities, or when the artifacts are not files but rather information with some meaning, such as describing personal skills, specifying the content and the interoperability between separate and even identical systems becomes more challenging.

Queirós et al. [Que11] have brought up different strategies for integrating an e-portfolio system into a learning management system, which can also be considered when other types of applications are integrated into e-portfolio platforms. They have divided the integration strategies into three types: data, API, and tool integration. Data integration is used to transfer data between the systems, and the data presented in a common format is supported by both of the systems. Queirós et al. do not make a specific division based on the content: HTML as a markup language as well as Leap2A as an Atom-based e-portfolio portability and interoperability specification are brought up equally. API integration provides the developers with features to implement plug-ins as a part of the existing platform. These implementations can be used to access the information between the systems. Tool integration provides an extension point to allow remote tools to be integrated into the platform.

The interest of this thesis, when considering most of the implemented applications and the way in which they are being provided for users, lies in the data integration with the requirement to include descriptive metadata. The standalone applications are managed by the university, and providing all these applications separately is arguable. However, providing some of the tools integrated as plug-ins in the system makes sense, for example, when it comes to writing reflections on a learning outcome. The user can be supported in his or her reflection by integrating *JobSkillSearcher* in order to browse for the terms that have been covered to conceptualize the topics and terms within a larger concept.

6.3.1 Interoperability specifications

To support the transferability of information, different interoperability specifications have been created. Portfolio interoperability standards are still evolving, and until recently there have been no specifications that would have been clear front runners. There have been very few public interfaces for the use of external systems. Therefore, importing and exporting e-portfolios from one system to another is truly problematic.

The Leap2A community has divided the information that is often included in e-portfolios into three separate categories:

- Information about the portfolio owner, abilities, achievements, experiences, activities, goals, plans, etc.
- Digital artifacts created or jointly created by the portfolio owner.
- Written entities, such as blog posts, comments, reflections, etc., which are not specifically about any of the above.

To improve this situation, the Netherlands Institute for Normalisation has published the National Technical Agreement (NTA 2035) for the exchange of e-portfolios. Janssen et al. [Jan11] have stated that despite the fact that several e-portfolio software providers have agreed to support the NTA, the deployment of the specification and thus importing and exporting the e-portfolios using the exchange format is limited.

Other interoperability specifications were reviewed in *Publication 6*. The XML (eXtended Markup Language)-based IMS Learner Information Package (IMS LIP¹⁸) specification is used to manage students' personal information [Epc03] in the transferring of student-specific information between distinct systems. Another standard developed by the IMS Global Learning Consortium, the XML-based IMS ePortfolio¹⁹, provides the means to also define the content of the portfolio. It offers the possibility to transfer information between different systems that use different solutions to store and present the information.

The InterOperability Project, in association with the development of LEAP 2.0 of JISC CETIS, has designed the Atom-based Leap2A specification²⁰ also to exchange the content of e-portfolios. Information is divided into three parts: 1) personal information about users, 2) stored artifacts, and 3) short writings and descriptions. Leap2A is mainly intended for e-portfolio systems that allow the users to manage their own portfolios rather than for defining institution-wide information [Gra10]. In the richness of content, Leap2A reminds one of the IMS ePortfolio, but the goal has been to keep the system simple, compared to other more complex specifications. However, Leap2A enables the user to define the abilities as given at a URL on the server responsible for the definition. This offers the possibility to even define one's own skills [Gra10].

All of the specifications can be used to exchange information between an e-portfolio system and an external application, including for the interoperability between e-portfolio systems. The main features of the IMS LIP, IMS ePortfolio and Leap2A may be seen in Table 28.

¹⁸ <http://www.imsglobal.org/profiles/>

¹⁹ <http://www.imsglobal.org/ep/>

²⁰ http://wiki.cetis.ac.uk/LEAP2A_specification

Table 28: Comparison between three e-portfolio specifications.

	User-related information	Digital content	Other
IMS LIP	<ul style="list-style-type: none"> - Personal data - Goals - Objects of interests - Skills and knowledge 		
IMS ePortfolio	<ul style="list-style-type: none"> - Skills and knowledge - Goals and plans - Ownership information 	<ul style="list-style-type: none"> - Artifacts - Evaluations of the work and testing results 	
Leap2A	<ul style="list-style-type: none"> - Skills and knowledge - Objects of interests - Working history 	<ul style="list-style-type: none"> - Audio, video, multimedia, text - Metadata about the information 	<ul style="list-style-type: none"> - Blog entries - Descriptions about the completed tasks

6.3.2 Testing export/import functionalities

In terms of the integration of the systems, semantics and context awareness play an important role. E-portfolios and thus learning artifacts (should) include a large amount of meta-data to specify the artifacts, their meaning and their relations. This should not only be done to help the automatic processing of these artifacts, but the information should also serve the users' needs. *Publication 6* introduces tests with ePET²¹ [Cot07] and Mahara e-portfolio platforms to find out the current status of implementations. They both have Leap2A-based functions to support transferability. The results show that there is still a great need for development: whereas exporting an e-portfolio from ePET and importing it to Mahara was uncomplicated and the information was transferred successfully, completing the operation vice versa was not that successful. The files that were uploaded to the personal e-portfolio in Mahara as artifacts did not end up in ePET. Instead, the information related to the files was shown as blog posts in ePET, and the files themselves were actually lost. This indicates one of the challenges that the interfaces of the systems contend with: different systems and also different configurations of the same systems will not share all of the tools and capabilities that can be used to manage the e-portfolios and their content. Although the specification would have all of the tools describe the content, what will happen if, as a simple example, the system receiving the e-portfolio does not support the uploaded files? Will the files be discarded?

Another more profound test involved exporting a portfolio from the Mahara installation and importing it into another, exactly identical installation on a different server. The e-portfolio that was created for the testing purpose included profile information, uploaded artifacts organized in folders, blog posts, plans for the future, two different results about personal learning styles (determined by third-party plug-ins distributed in association with Mahara called *My Learning*), and three individual views (showcases) of the personal information for different purposes.

²¹ <http://www.eportfolios.ac.uk/ePET>

After the e-portfolio was exported from the first system, it was reportedly successfully imported into the other installation. After this, the transferred portfolio was compared to the original one. Although the imported portfolio seemed to have all of the information, there was a problem with the results of learning styles, which first appeared in one of the views where the results of the two tests had been included. This observation is presented in Figure 31, one of the original views of the e-portfolio on the left and the transferred one on the right.

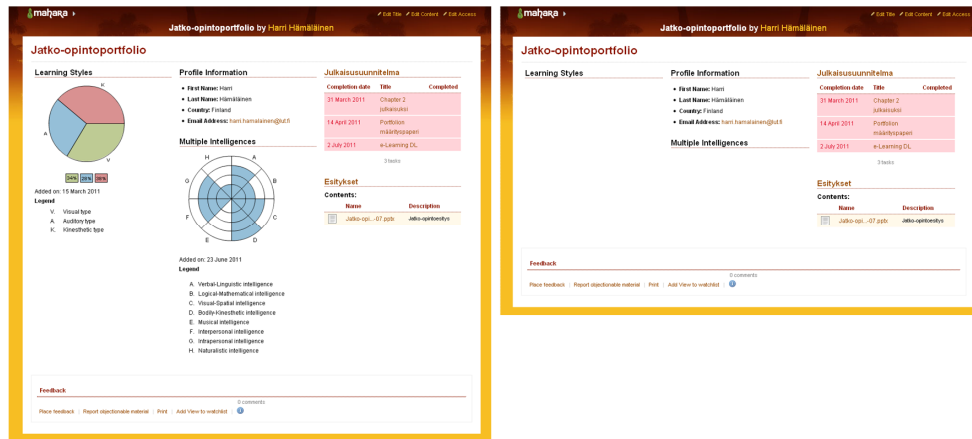


Figure 31: Views from the original and transferred personal e-portfolios.

The cause of this issue was determined by inspecting the Leap2A XML file. Information about learning styles was only imported as the view in which it was embedded. However, the way it was embedded did not seem functional: the artifact was referenced as an object with a hard-coded URL link to the multimedia file of the plug-in in the original server. Thus, in our case, when the system was shut down, no results were shown. If the previous service provider cut the access, the result would be the same. This, however, is not the major problem. Of greater concern is that the actual information in the form of skills was not transferred at all. Having the information in its original form and meaning is one of the true values within the e-portfolios containing those artifacts that are reusable information, not merely some files or images.

In the case at hand, the reason for this failure is not because of the limits of the specification used for the transfer. It would have supported defining of the results as skills or characteristics. The implementation of the Leap2A interface cannot be faulted, either, since the results of the tests in the database of Mahara are not described in any reasonable way that could have been either human or machine readable without knowing the internal functionality of the precise plug-in. Moreover, it is not a defect within the platform or its database that supports storing information flexibly. Consequently, the only alternative left is the person or instance responsible for the implementation of the plug-in. At the time the plug-in was implemented, the platform did not have the interface for exporting e-portfolios, and the Leap2A specification had not even been published. In other words, there is no one or nothing to blame in this case, but the task is still not successfully accomplished. What can be learned from this?

The example given highlights the challenges that developers will encounter as more plug-ins are implemented. Naturally, the implementations of interfaces to enable

transferability have to be improved such that they take the type of information and metadata into account. However, an important observation is that these aspects need to be considered with extreme care when new plug-ins are implemented and accepted as a part of distribution. Otherwise, there is a great risk that when some of the open-source platforms and the development thereof receive more attention, and when new plug-ins are being published and used by students to create content at a time when the e-portfolio is transferred from a system to another, some of the personal information will be lost for good.

6.4 Discussion

Although the learning process produces a great amount of information, quantity does not translate into quality. For example, when applying for a job, there is no reason for one to demonstrate information and skills that have no meaning for the job in question and that would probably draw attention away from the valid information. To maximize the benefit of a showcase e-portfolio supporting a job application, the e-portfolio primarily has to be customized to respond to the job advertisement and the skills demanded. Those are the most important points to be demonstrated.

The implemented applications presented in this thesis are primarily connected to e-portfolio construction through the learning process. Although the comprehensive exploitation of these tools requires support for construction in the long term, the usability of these tools can be already demonstrating during the set-up and creation of the grounds for individual e-portfolios, and the positive effect of these tools on the construction can be demonstrated when their role is identified in the construction process. As the pilot with the implemented tools indicated, useful information can be produced with them, and they can be put into use with little intervention from or additional load for the organization.

Lending support to setting up the e-portfolio with the information already available on other systems, and supporting the construction process by means of study guidance and teaching are not the only matters to be taken into account when considering the importance of e-portfolios. If, as promoted, e-portfolios are to be used over one's lifetime to support lifelong learning, there must be the means to transfer them in their entirety from a system to another. Transferring only the artifacts is not satisfactory; the descriptive metadata, relations and hierarchy between the entities also must be preserved in order not to lose the valuable organization work. Since presumably there is not going to be one dominant platform for the management of e-portfolios, interoperability standards and specifications play an important role. This also concerns external applications when interfaces to export and import information from one system to another are implemented.

The few sources ([Bal10b], [Lin10]) that speak to the current implementations for transferring information between open-source e-portfolio platforms seem to entertain an overly optimistic view of the current status of interoperability implementations. When the first generation of "native" e-portfolio users needs to transfer their e-portfolios to another platform, these practices need to have been established. Otherwise, the plans for using e-portfolios as a tool for supporting lifelong learning will take a long step backwards.

Although interoperability standards are still evolving and their life cycle in terms of e-portfolios is mainly in its early stages, interoperability should be taken into account more in the implementation phase of the platforms and associated plug-ins. In a way, this is also a chicken-and-egg situation: whilst the interface implementations to support interoperability in a few e-portfolio platforms have just recently seen the light of day, this requirement has not been taken into account earlier.

Interoperability standards also play a vital role when the applications such as the ones presented in this thesis are being integrated or when interfaces are provided. If study plans are imported into portfolios, the content, structure, relations, and scheduling must be maintained. Learning styles, as another example, consist of preferences (which could be indicated as a subclass of skills) based on different learning models and tests. Peer reviews are composed of assignments, of evaluations thereof and of feedback received, but also of feedback given. One of the challenges is to preserve all of the metadata of this information so that it is not solely the reflection of the outcomes of the external tools but is also descriptive and reusable. When a decent level of success with the core of e-portfolio export and import functions is reached, extreme care still must be taken with the plug-ins. To verify the transferability of content produced with 3rd party plug-ins, the community has to define strict requirements concerning how the information is described and stored, and there has to be reliable means for approving these plug-ins. Otherwise, there is an enormous risk that non-functional plug-ins will be distributed and used.

7 Implications and limitations of the thesis

In this thesis, the learning cycle has been combined with the most common phases of the portfolio construction process. On the one hand, the cycle reflects stages of each individual course: students are to set goals, complete the courses, review what they have done and draw conclusions. On the other hand, the same cycle is found on a larger scale of the learning process. Applications matching these phases of the learning cycle have been implemented and introduced, and the meaning for the learning process and by extension for supporting e-portfolio construction has been discussed. The key results are the tools, whose operability and usefulness have been examined by analyzing the results that they have provided.

7.1 Implications for practice

Considering what e-learning and Learning Management Systems did for teaching, it is worthwhile to think about what e-portfolios can do for learning. Soyoz [Soy10] believes that e-portfolios are going to be the next big thing of the education system, and new technologies are going to play a fundamental role in meeting the challenge of adaptation to widespread use of e-portfolios. Different purposes for e-portfolio use will guarantee that there will be a wide variety of approaches and thus different emphases on the features that are going to be provided to students. The role and purpose of the e-portfolio in this thesis has not been limited to only one of the definitions, but includes features from several of them, forming a hybrid e-portfolio.

E-portfolios have been praised for some time now. The requirements for adoption of e-portfolios, such as institutional-level commitment and support provided to students, have been brought up. However, solutions concerning how to actually support students have either been superficial or have given student a way to manage the content of their portfolios but have not supported the development of the student. Pedagogically speaking, there is much improvement to be made in the area of e-portfolios, and this thesis introduces some technical solutions that can be utilized as a part of the improvement process.

Comprehensive testing and evaluation of the tools introduced in this thesis integrated as part of the e-portfolio construction process would require complete institutional commitment. The first step would be introducing and providing an e-portfolio solution to the students, and thereafter taking the approaches and tools introduced in this thesis as a part of study guidance activities. As the chapter on peer review indicated, the role of teachers is extremely important. These are the fundamental activities that are required at the moment for wider adoption of student e-portfolios. As widespread adaptation to e-portfolio solutions in universities in Finland is still yet to come, this thesis concretizes a few important stages on the cycle that are important to take into consideration in the

development and deployment of e-portfolios in institutions. As the commitment of an institution plays an important role in successful adoption of student e-portfolios, a clear link between existing practices and e-portfolio construction reflecting the learning cycle has been demonstrated and supported by implementing the computer applications. The next challenge is to bring these practices to e-portfolio construction, rather than to relegate them to being separate tools in teaching and study guidance.

Research also shows that technologically speaking, there is still a fair amount to do if the existing tools for lifelong learning are to be used without engaging too tightly with one service provider, not to mention with one particular environment. The specifications and standards need to support transferability, and the role of open-source developers providing generic solutions is important.

7.2 Implications for further research

JobSkillSearcher provides a solid basis for analyzing computer science job advertisements in Finnish. Whereas job advertisements pertaining to computer science have traditionally been analyzed in English-speaking countries and locations, nowadays, Finnish advertisements in particular can be analyzed. The approach of presenting the results not only as a frequency of the skills but also as the interrelationships and frequency between the skills provides information about the requirements on a larger scale. It would be interesting to see if this information can really be used to motivate students in their learning activities. The increasing database with a large amount of already recognizable terms can be used for deeper analysis of the information or as a good basis when thesauri or ontologies for the skills related to computer science are created.

It would also be interesting to take a closer look at how different learning styles can be taken into account when e-portfolio platforms and processes are designed and introduced as well as at how these learning styles may affect the choices students make on their learning path. How or if this information can or should be used to support students in their studies in advance is interesting.

The information produced using an e-portfolio platform should be transferable to other similar platforms and to other systems that might benefit from this information, such as knowledge management systems in companies. Thus, the importance of interoperability to the success of e-portfolios will be enormous. Although the issue of interoperability and its importance has earlier been recognized and actions have been taken, implementations have not yet reached a credible state. Even though the transferability of e-portfolios does not directly relate to how the construction process is managed in universities while these are adopting e-portfolio solutions, it is obvious that this will have an effect on whether students are motivated to spend their time using the provided solutions. Therefore, the current status of interoperability work was also referred to in this thesis and will remain one of the most important issues in e-portfolio research.

Also, there is much research left to be done on how actions to support e-portfolio construction will affect deployment, student commitment, and portfolio quality. Whether or not e-portfolios have an effect on students' learning process is eventually far more important than whether or not the effect can be seen in the look and expanded content of the portfolios

7.3 Threats to the validity of the thesis and limitations thereof

The students who took part in the different pilots presented in this thesis were mostly students at Lappeenranta University of Technology and more precisely, the majority of them were studying Information Technology as their major or minor. This raises a question about the external validity and generalization of the results to other institutions and different contexts. The learning cycle and portfolio construction process are both introduced generally and they are neither related to the institution nor the discipline. The chapters linked to different phases of learning cycle present some topics that have also been observed in other studies. Making general assumptions about students in general, e.g. from their learning styles, was avoided, but the collected results have been used to categorize the students into different groups whose selections and success have then been analyzed. Also, the implemented solutions can be applied and put into use in different disciplines and in different degrees, but some adjustments may be needed.

Another issue that may be criticized is the population sizes in singular research presented in this thesis. Larger sample sizes would have provided more reliability to the results. However, considering potential improvements for the process, it is important to notice that there can be differences. Although the summary of the *learning styles* test results mostly corresponded with the results collected by [Ala10] in a comparable environment, the group of students was not necessarily unbiased. The test was on a volunteer-basis and it was advertised not only on information monitors but also in some particular courses in the Department of Information Technology. Also, the students were evaluated using only one of the numerous learning style models, and the learning styles themselves were determined using only one test.

Although the peer review processes were conducted in a same course in three consecutive years, the number of students each year was relatively small. Students' peer reviews were never graded or awarded extra points, so there is a chance that some of the students did not put forward their best efforts on the task, causing unwanted differences in results.

The impact of providing a web-based tool for study planning was not properly researched at the time it was introduced. Although the students who were interviewed all viewed it as a useful and efficient tool, its effect on the quality of study planning was not examined at all.

The current technical solution with *JobSkillSearcher* (opting out semantics and basing the solution on parsing algorithms) causes limitations in the research of job advertisements. With the enhancements to the vocabulary, the formation of ontologies of the terms, and the improvement of identification methods, correlation with human annotators can be improved. Currently, the identification and categorization of the skills were completed by the author of this thesis, which also is also a limitation in terms of recognition. The current vocabulary and recognized terminology are based on computer science skills, but the same solution can be used to collect, analyze and present the results of other areas as well. The solution is based on the requirements of job advertisements published in Finland and mostly in Finnish. Thus, the results have an undeniably geographical bias on purpose. Contrary to some earlier solutions to automatically analyze required skills in job advertisements, human annotators were

supposed to identify all the terms they deemed important rather than selecting from a strictly defined list of skills, making the task more challenging. However, the ability of *JobSkillSearcher* to automatically process the advertisements and provide the results in human readable form for the purpose of linking and grouping skill sets together on this scale can be shown.

All the pilots and tests presented in this thesis were carried out separately from the e-portfolio construction process. The importance and benefits of the introduced solutions and their relation to the portfolio pedagogy were demonstrated based on theory and earlier research related to e-portfolios, but have not been proven in practice. This would have required a longitudinal study and comprehensive introduction of these solutions after implementation, at least at the level of a discipline. It would have needed commitment not only from the students and teachers, but also from the institution, as stated when integrating the e-portfolio into university services was discussed.

8 Conclusion

The main objective of this thesis was to demonstrate 1) how certain implemented computer applications relate to the learning cycle through teaching, learning, and personal development activities; 2) how the technical and quality aspects of the applications benefit students; and 3) how the applications can be put into use in developing e-portfolio construction. Although the ongoing introduction of e-portfolio platforms has created brand new possibilities for students to collect artifacts in order to show their acquired skills, problems have also emerged. If no support for the construction process is provided, these systems often act as mere data repositories where organizing and analyzing of artifacts is neglected. Important phases in the learning cycle, such as planning and especially reflection, are often not taken into consideration when students build personal portfolios.

The relation and importance between portfolio construction and the learning cycle has been underlined in this thesis. When one examines the different phases in the cycle of e-portfolio construction more closely, common objectives with other stakeholders, such as universities and industry, are apparent. The information and assignments from these institutions can be used to support students' development processes, when the student perspective is taken into account, supported at the administrative level and in teaching, and linked with portfolio construction.

The importance of study planning has been recognized from the institutional side, but it is also valuable for the students. Before institutions started to pay serious attention to the study planning of their students, it was often neglected or disorganized. To facilitate the university-managed but still student-driven planning, *WebTUTOR* was implemented. It contained the degree curricula modeled in the database and was used to assist in the selection and verification of valid courses for each personal study plan. This made the creation of valid plans that followed the guidelines and their validation for administrative purposes more efficient, and the management easier. The importance of personal study planning for personal development and e-portfolio construction is obvious. The scheduled courses reflect the goals that students have set for themselves. Thus, the personal study plan plays a pivotal role for the reflection. On the other hand, considering the organization of the information in e-portfolios by technical means, a personal study plan provides a rational structure as a basis for creating the personal portfolio, collecting artifacts and reflecting their importance.

The selection of program, major and course choices is affected by personal interests, preferences and desires, but also by vocational goals. The requirements set by industry play an important role in the selected skills students should acquire during their studies. To provide better and more exact information for the students concerning these requirements, *JobSkillSearcher* was implemented. It is used to collect job

advertisements and visualize the frequency of the skills and their respective applications. The tool is capable of identifying a large number of ICT-related hard and soft skills, thus showing the students the diversity and large variety of required skills. The evaluation of the tool indicates that the identification of technical skills listed in job advertisements is of decent quality and that the results are in line with other relevant studies. On the other hand, the tool's identification of soft skills is more challenging and does not necessarily correlate with those experiences of graduates about their importance in the world of work. All the collected information shared with the users can be used to recognize the typical requirements and to help users set personal goals based thereon. In addition to personal development, this information can be used as a glossary when one analyzes the content of portfolios and categorizes the information. Another issue that importantly impacts the learning process is one's personal style of learning. Each individual has her or his own preferences and best practices in learning that are for him or her more efficient than others. However, students do not necessarily recognize these preferences even at the simplest level, and thus are unable to take these into account when planning their studies. The *Learning Styles* application was implemented to provide a centralized platform where different tests based on different learning theories could be taken. From the results, students are able to recognize their personal preferences, as well as their strengths and weaknesses, and to follow possible changes thereof over time. Since learning styles relate to personality types, students are able to use these results to get help in determining the types of jobs best suited to their personality, to support their selections and to highlight their accomplishments. At the same time, this information can be used to analyze different learners' success in different courses.

Reflection plays an increasingly important role, especially in the later phases of learning, and is the binding factor of most of the topics of this thesis when learning and e-portfolio construction are considered. Reasonable reflection requires recognition of personal goals and an ability to evaluate personal accomplishments and skills. This leads to the challenges of self-evaluation. Inexperienced students especially encounter difficulties in evaluating themselves and recognizing their level of knowledge. To provide a better basis for self-evaluation, peer review has been used as a tool to give more feedback to students and to show different solutions for the problems raised by their peers. Since existing open-source tools did not provide sufficient features to carry out the defined anonymous code peer review process, *MyPeerReview* was implemented. Using peer review as a part of student assignments showed that the skill of evaluating can be taught and evaluations in general between teachers and students correlate well. As the peer review and evaluation process is associated with self-evaluation, it was also used to monitor and improve the self-evaluation skills of students. Making students undergo the peer review process is a way of supplying them with tools to compare their own solutions to others' and to be able to evaluate their own skills better and thus reflect on their own learning of their objectives. In using the peer review as a part of programming education, the accuracy of students' self-evaluations compared to that of the teachers' evaluations was improved within our small group of students. Thus, peer review is a tool used not only to provide more feedback for students and show them different ways of solving tasks, but also to improve self-evaluation and reflection of students' own achievements. In addition, for e-portfolio needs, the received feedback and improved experience can be used in the evaluation of artifacts and personal skills.

The results of this thesis within the framework of constructive research and implemented applications are summarized in Figure 32. Every tool introduced in this

thesis was based on practical needs that surfaced in teaching and study guidance at LUT and that were identified as a part of the learning process. The solutions are connected with existing theories and earlier research in the field. Validation for the results on different bases (based on the purpose of the use of each tool) was completed. Finally, tool implementations were linked to the e-portfolios by showing the significance of the results in the needs of personal development and construction of the e-portfolio.

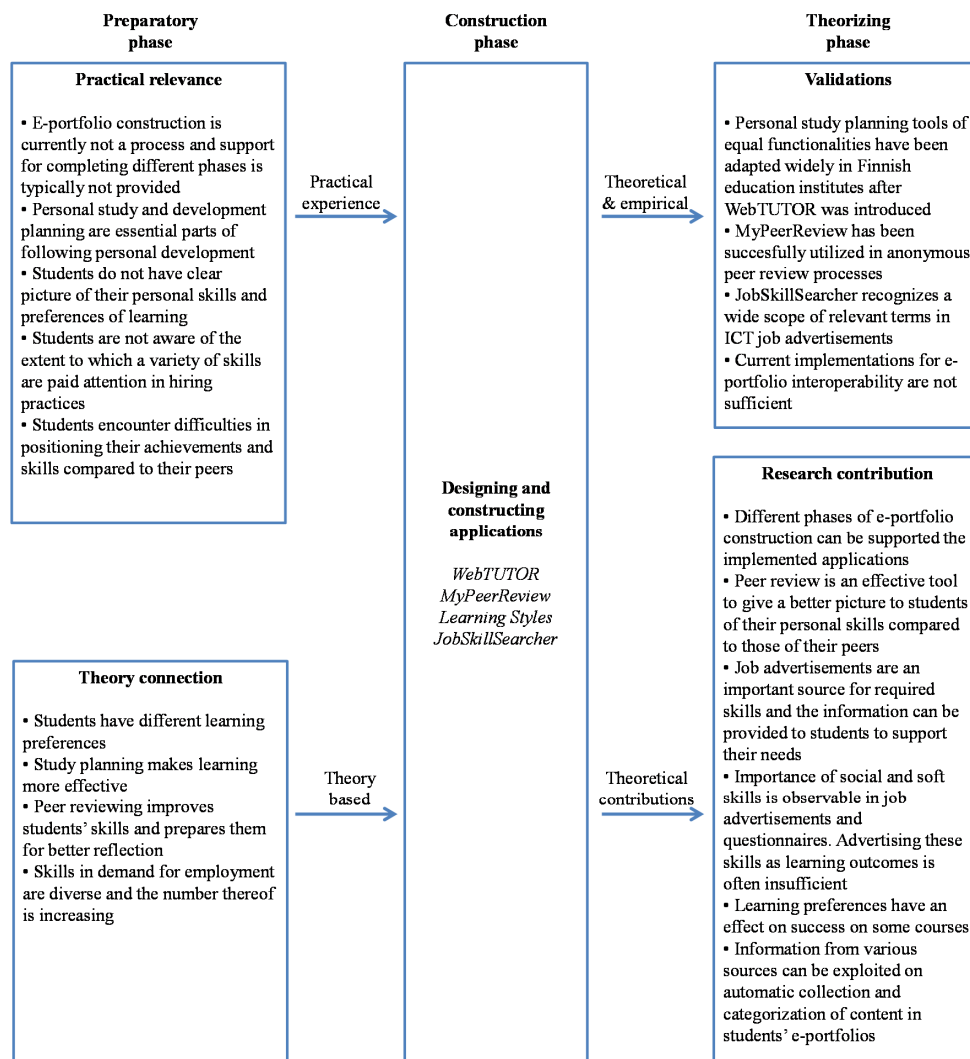


Figure 32: The results of this thesis within the framework of constructive research.

The original research question in this thesis is how construction of an e-portfolio can be supported with computer applications. Each of the implemented applications introduced in this thesis can be linked to the phases of e-portfolio construction process, supporting this by providing more information that can be put into use. The applications are also connected to the three primary stakeholders related to personal development: industry, university, and the student. In Figure 33, the implemented applications and their placement related to these stakeholders are presented. Although in this thesis the role of

the e-portfolio is considered to be learner-centric, it is obvious that all three parties are needed to form the requirements, content, and use in order to enable successful adaptation of e-portfolios. Although the applications are tied to the process of constructing e-portfolios and to improving the process itself, their significance does not depend only on this process. Each tool can be used individually for other purposes that benefit the users.

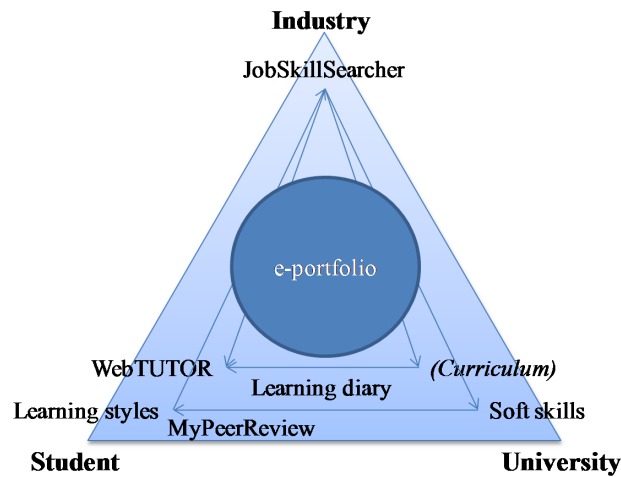


Figure 33: Contributions of this thesis and placement thereof between the three stakeholders.

The different steps of e-portfolio construction may be supported by means of the theoretical analysis and implementation of the tools presented in this thesis. All these phases of e-portfolio construction are part and parcel of e-portfolio construction, but more importantly, they support the learning process and personal development. Development that is supposed to continue after graduation in the world of work relates to lifelong learning. Thus, the individual tools and a platform for collecting the information are not enough; the means must exist to guarantee interoperability when it is needed because of changes in life, such as graduation.

Although the primary purpose of the tools is to directly support individual students and make them think about the personal skills, goals and requirements they should accomplish, the information that is collected can also be used technically to support the construction of students' e-portfolios. A structure for the portfolio can be created using the personal study plans; courses can be indexed by descriptions using the existing database for keywords; teaching methods and the personal skills required in the courses can be brought forward to the students in support of their planning, self-evaluation, and reflection on the values pertaining to their learning styles. The aim is definitely not to automatize the work students are supposed to do, thus rendering all e-portfolios more or less equal-looking, but rather to provide a good basis with beneficial information for providing students with a better point of departure for adopting e-portfolios as a part of their learning process.

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