RAIMO HÄLINEN

An Evaluation Method for Virtual Learning Applications

ACADEMIC DISSERTATION
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Acknowledgement

This research process started at the beginning of the year 2001, when I decided to continue my studies in Information and Computer Science. The first aim was to update my knowledge concerning current ICT knowledge, and theoretical teaching skills. However, after a discussion with Pertti Järvinen I changed this idea to start academic research. He proposed that the better way to update ICT knowledge and current theoretical and practical knowledge is to start research and try to achieve a Doctoral Dissertation.

The original research idea was formulated as, how to select a virtual learning environment to use in teaching at a university of applied sciences. A learning method, which should be taken into account, is the problem based learning method used in face-to-face learning courses, when considering suitable virtual learning applications. Preliminary discussions with other faculty members revealed that there are many potential virtual learning applications available to choose. Whilst almost everyone has their own thoughts and opinions concerning which one of the available virtual learning applications is preferable, there were not so many thoughts on how to select a virtual learning application or whether it should use an evaluation method or make a selection by using feelings. After searching virtual learning applications and trying to find out evaluation methods and methods, a research problem was revealed and clarified. The research problem is how to develop or select an evaluation method for a virtual learning application for this decision situation.

I have been very lucky to have Professor Pertti Järvinen as my supervisor. He has reviewed this work many times and offered comments throughout different phases of this research project, and encouraged me to continue research work.

It has been possible to finalize this research with the help of other researchers and staff members. By taking part in the seminar group at the University of Tampere, I was offered a way to develop as a researcher and to learn how to write academic research. The members of the seminar group are valuable partners, and I am very pleased with the possibility to be as a member of that group. I should list all the members. However, senior member Eero Lähteenmäki offered good practitioner's advice many times, how the ICT business is in reality, and how it should be taken into account in academic research. Ph.D. students Mikko Ahonen and Marko Mäkipää have also been valuable partners and co-researchers. Pertti Järvinen's summer seminars during this research period offered the possibility to meet foreign researchers, who reviewed research texts and proposed valuable advice, and equally important for me, by asking questions.

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Finally, the deepest thanks belong to my family, my wife Maarit and our children Lauri, Juho and Salla. It has been a real situation many times during this research project that the father, who is physically in the house has not been present in reality. This means that their expectation that this work will be finished becomes more than welcome. The hope that the father is again available for other matters to do with them has encouraged me to finalize this thesis. A human being as a thinking creature is an outsider most of the time during the research process.

Livohka 30.5.2011

Raimo Hälinen

Abstract

The importance of evaluation methods has been recognized as research subjects since the 1970s. Researchers suggest evaluation methods to use, as a tool for producing valuable information to support decision-making and justifying information system investments within organizations. An evaluation situation is a unique phenomenon in an organization and depends on time. Evaluation processes are identified by ex-ante, ongoing and ex-post evaluation. Off-the-shelf packages are considered to a small and medium sized organization as a solution, when decision-makers are solving the needs of information systems. At formal learning organizations, in many cases, the use of virtual learning environments is based on teacher's actions, not systematic evaluation and decision-making in previous years. At the organizational level, decision-makers are slowly recognizing the need for strategic and tactical aspects, and the need for systematic evaluation before making a decision; which kind of virtual learning environment meets the strategic, tactical and operative requirements and satisfies properties of a learning model.

This dissertation investigates an evaluation situation and evaluation process, and it identifies stakeholders' roles in the evaluation process as an evaluator and a decision-maker. The purpose is to develop an evaluation method based on requirements of strategic, tactical and operative levels of organization. The evaluation criteria are also identified by using the collaborative problem based learning method.

An ex-ante evaluation method for a virtual learning application is developed and demonstrated. The developed ex-ante evaluation method utilizes the analytic hierarchy process (AHP)-method as a calculation tool, which is used to demonstrate the evaluation method's usability. The purpose of demonstration is to show how the developed evaluation method can be used in ex-ante evaluation.

The result of this thesis is an evaluation method for a virtual learning application, showing that an evaluation method can be used in the specified evaluation situation at a formal learning organization. The developed ex-ante evaluation method takes into account requirements of four stakeholder groups: students, teachers, ICT-staff, and executives, properties of learning method and derived features of a virtual learning application.

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List of acronyms

AHDM	Ad-Hoc Decision Making
AHP	Analytic Hierarchy Process
ALT	Association for Learning Technology
ANP	Analytic Network Process
ATD	Architecture Theory Diagram
BSC	Balanced ScoreCard
BSEM	Balanced Scorecard Evaluation Method
Blackboard	A virtual learning application
CAP	Cots Acquisition Process
CARE	Cots Aware Requirements Engineering
CCS	Cots Component Selection
CEP	Comparative Evaluation Process
CF	Conversational Framework by Laurillard
CGEM	Cronholm and Goldkuhl's Evaluation Method
CGLE	Collaborative Group Learning Evaluation
CISD	Cots-based Integrated System Development
CLM	Constructivist Learning Method
CLW	Collaborative Learning Work
CPBL	Collaborative Problem Based Learning
CPBLM	Collaborative Problem Based Learning Method
CPBLEM	Collaborative Problem Based Learning Evaluation Method
CSILE	Computer Supported Intentional Environment
CSLW	Computer Supported Learning Work
CSCW	Computer Supported Cooperative Work
CBWL	Communal Web-based Learning
CMS	Content Management System
COTS	Commercial Off-The-Shelf Software
CPA	Content Producing Application
CRE	Cots-based Requirement Engineering
DIANA	Dialogical Authentic Net-Learning Activity
DM	Database Management
DS	Design Science
DSR	Design Science Research
DRP-RS	Design Research Process by Rossi and Sein
DSS	Decision Support System
EDM	Ethical Decision Making
EPEF	Educational and Pedagogical Evaluation Framework
ETHICS	Mumford's ETHICS method
ERP	Enterprise Recourse Planning
EVA	Economic Value Added
EXEM	Executive's Evaluation Method
FLE	Future Learning Environment
GSS	Group Support System
IA	Infological Approach
ICTEM	ICT-staff's Evaluation Method
ICT	Information and Communication Technology

IR	Implementation Research
IS	Information System
IT	Information Technology
LDAP	Lightweight Directory Access Protocol
LLT	Lifelong Learning Theory
LO	Lexicographic Ordering
LM	Learning Method (model)
LMS	Learning Management System
MIS	Management Information System
LLLS	Maes et al.'s life-long learning by sharing
Moodle	A virtual learning application
NPV	Net Present Value
OAM	Option Analysis Method
ODM	Organizational Decision Making
Optima	A virtual learning application
OTSO	Off-The-Shelf-Option
PBL	Problem Based Learning
PDM	Political Decision Making (Model)
PCA	Principal Component Analysis
PET	Proactive Evaluation Technique
PORE	Procurement Oriented Requirement Engineering
SAAS	System Analysis, Accounting Strategy
SCORM	Sharable Content Object Reference Model
SE	Software Engineering
SOLO	Structure of Learning Strategy
STA	Socio-Technical Approach
STACE	Social-Technical Approach for Cots Evaluation
SUEM	Student's Usability Evaluation Method
TAM	Technology Acceptance Model by Davis
TUEM	Teacher's Usability Evaluation Method
VHM	Vershuren and Hartog Model
VLA	Virtual Learning Application
VLE	Virtual Learning Environment
VLEM	Virtual Learning Evaluation Method
VLP	Virtual Learning Platform
WAAM	Wohlin Amschler Andrews' Model
WebCT	A virtual learning application
WBT	Web Based Training
WS	Work System by Alter
WWW	World Wide Web

Chapter one

1Introduction

Small and medium size organizations are nowadays quite often acquiring software and trying to find out off-the-shelf packages. In Finland, according to Rönkkö et al. (2008) on a survey of the Finnish Software industry, the revenue of the software industry was 1.5 billion euro in 2007. Software acquiring at small and medium size organizations can be a difficult task, because company owners and managers are not familiar with IT-consultants' language. They are uncertain what they are getting, and they are often wondering what the properties and features of the offered software are and what they really need for the business processes. Software houses are nowadays developing worldwide software products (artefacts), and the properties and features are based on general needs of industry or branch levels. Off-the-shelf packages are easy to acquire or hire and are often quite simple to install. However, the requirements of a certain department in an organization are not necessarily satisfied, and the software companies are offering modifications as a general solution to this problem. The modification projects demand that organizations are willing to carry out a definition project in order to specify required properties of software, so that it is possible to evaluate available options. This underlines the need for appropriate evaluation methods, which are applicable at different stages of acquisition, and members of the project group can utilize these in the real life evaluation situations.

This thesis focuses on the evaluation methods and metrics, which can be used for an evaluation during software acquisition processes. The main purpose is to evaluate a utility of an application and to propose suggestions and recommendations for decision-makers. From the management perspective Symons and Walsham (1988) defined evaluation by using the following expression: "The primary function of evaluation is to contribute to the rationalization of decision making." Remenyi et al.'s (1997) definition of an evaluation process is "a series of activities incorporating understanding, measurement and assessment. It is either a conscious or tacit process, which aims to establish the value of or the contribution made by a particular situation. It can also relate to the determination of the worth of an object." Farbey et al.'s (1999, p. 205) definition is "a process that takes place at different points in time or continuously, for searching for and making explicit, quantitatively or qualitatively, all impacts of a project." Based on Symons and Walsham's, and being sympathetic with Remenyi et.al's and Farbey et al.'s definitions, I conclude that an evaluation is a process and an aim of an evaluation is to rationalize decision-making by offering decision makers' information, which is based on a systematic evaluation process and suitable evaluation method.

When I compare planning, organization, motivation with evaluation, I can state that all are activities of a decision process. An evaluation process differentiates from the planning, the organizing and the motivating activities and the reasons are 1) the main aim of evaluation is to provide information for decision makers, 2) an evaluation process should precede planning and organization activities, and 3) an evaluation process is useful to utilize during and after planning

and organization activities. An evaluation process can be classified ex-ante, ongoing and ex-post evaluation process. In this thesis, the main aim is to find out an evaluation method for a virtual learning application, which is easy to use, and that it can be used to produce suggestions and recommendations for decision-making process.

1.1 Background and motivation of the research

The main interest of an evaluation process in this research is based on the two decision problems. Firstly, how many virtual learning applications are available, and how to provide decision-makers with the useful information concerning these virtual learning applications. Secondly, how properties of a virtual learning application and teaching and learning models should be included to evaluation method.

From the practical point of view, teaching and learning models are the interesting questions, since a case organization utilizes different learning models and integrating virtual learning more closely to classroom teaching is a strategic objective. At the starting time of this study, the case organization was using at least three different kinds of virtual learning application. During this research process, a decision was made that only one virtual learning application would be supported and all units should use the supported virtual learning application. However, this decision is not a constraint for this study, thus I try to construct an evaluation method for a virtual learning application, which can be used in the next selection process in the future.

A scientific objective of this research is based on the following reasons. Firstly, I was considering, how to develop my own research methods and how to attempt to solve a practical decision problem by using an available evaluation method, if this research process reveals that usable evaluation methods exist. This objective might be stated the following, the objective is to develop as a researcher. Secondly, the objective of this study is to construct available evaluation method to demonstrate an evaluation method and provide a contribution.

I can state that from a scientific point of view, there are at least two research paths to follow the selection process of evaluation method, or I try to construct a specified evaluation method for virtual learning application. A scientific objective of this study can be stated that I try to apply an existing evaluation method to the new evaluation problem and/or I try to construct a new evaluation method and demonstrate its usability.

According to Järvinen (2004, p. 98), a research belongs to design-science research, if the research question contains the verbs build, extend, improve or adjust. The verbs build or construct are included in our research question (problem). A scientific contribution of this research is either a demonstration of an existing evaluation method for a different problem, or the result is an evaluation method, which enhances or improves an existing evaluation method or our evaluation method is better than the best available evaluation method.

This research is a multi-science process. It needs knowledge of Information Systems and Education. The evaluation situation can be identified by investigating the features and properties of learning models, which can be converted to evaluation objects and evaluation criteria of an

evaluation method. Evaluation methods that are developed and utilized for evaluating different types of information systems offer a natural base to try to develop an evaluation method for a virtual learning application.

Irani and Love (2008, p. 43) asked the following questions. What is evaluated? Why is an evaluation process being done? Who are the participants affecting the evaluation process? When is the evaluation process carried out? How is the evaluation process carried out? Irani and Love (2001, 2002), and later Berghout and Remenyi (2005) emphasized that the most commonly used evaluation methods are the cost-benefit, which are used for ex-ante evaluation during the developing processes of applications. By considering cost-benefit models for evaluation for a virtual learning application, I claim that those models include executive's requirements, while other important stakeholders are not included. By analyzing cost-benefit evaluation, I point out that these models are developed mainly for the strategic point of view and hence the tactical and operative points of view should be taken into account. Therefore, I try to develop an evaluation method that includes stakeholders' requirements and objectives of the selected strategy of learning.

According to Cameron and Whetten (1983, p. 261 - 277) in order to measure organizational effectiveness, a researcher must answer to the following seven questions:

"1. From whose perspective is effectiveness (performance) being judged?
2. What is the domain of activity?
3. What is the level of analysis?
4. What is the purpose of evaluation?
5. What is a time frame employed?
6. What types of data are to be used?
7. Against which referent is effectiveness to be judged?"

Although those questions are mainly developed for measuring organizational effectiveness, I agree with Seddon et al.'s (1999) view that questions are relevant for evaluating virtual learning applications too.

The evaluation of information systems in theory and in practice seems to be a complex and 'difficult' phenomenon. Even hundreds of evaluation methods and metrics can be found by reviewing academic journals, books and published dissertations (van Grembergen, 2001; Hirschheim and Smithson 1988; Irani and Love, 2002, 2008; Berghout and Remenyi, 2005; Karlsson et al. 1998; Kontio, 1995a b, 1996; Serafeimidis and Smithson, 1998; Whittaker 2001). Evaluation research in Information Systems has been focused on the software development projects in earlier times and evaluation methods were developed mainly from the cost-benefit point of view. The software development projects were seen as typical investment projects, so return on investment was the main interest by management. Whittaker (2001) identified that the evaluation phenomenon is a "thorny problem". Consultants, researchers and practitioners have tried to simplify and categorize the complex problem with the goal of developing appropriate evaluation methods. Whittaker argues that, in practice, these developed methods are not used, and the problem of information system evaluation still exists. Whittaker (2001, p. 20) argues that the "Evaluation of information systems can be understood if I consider different types of

systems requiring different kinds of evaluation. This gives us a range of methods to apply. However, it seems that managers do not often apply these methods."

I agree with these descriptions and emphasize that the "thorny problem" still exists and more research is needed to solve evaluation problems. Berghout and Remenyi (2005) carried out a meta-analysis of the evaluation studies from the past eleven years, and found the following themes: IT and IS values, multidisciplinary nature of evaluation, importance of the stakeholders' analysis, organizational learning and life cycle management. According to Berghout and Remenyi's analysis, I can conclude that the stakeholder's role in this thesis is important.

The first impulse to start to investigate a selection process of e-learning environment and applications was based on the daily work as a teacher at the university of applied sciences. The second impulse was Salvatore March's comment (see Järvinen, 2010, s. 139) on the article that was reviewed in the doctoral seminar, and I will borrow it: "I believe one of the most significant problems in doing design science is the determination of appropriate evaluation criteria for the artefact produced. Clearly, this relates to your notion of goals of the artefact. Economists tell us that the goal of the firm is maximization of firm value. However, I must consider both long-term and short-term consequences in attaining that goal." It is good to recognize that March underlines that evaluation methods are not IT artefacts. He emphasized "*Design scienceresearch may contribute to the knowledge base by developing evaluation approaches but these are not IT artifacts. For example evaluating data representations requires metrics for measuring how well people understand a data representation."(see Järvinen, 2010, p.143)*

These comments show that evaluation and developing evaluation criteria are important for design science, and it is supported from the practitioners' points of view. The third motive to carry out this research is based on reviewed studies (Lin and Pervan, 2000 and Berghout and Renkema, 2001). Those literature reviews included the list of following weaknesses in evaluation studies:

a) A lack of formal IT/IS evaluation methodology,
b) A complete lack of IT/IS realization methodology,
c) A lack of understanding of IT/IS the investment evaluation methodology,
d) Long-term and enabling nature of investments,
e) Organizational collaborations,
f) Coherence of decision-making criteria and
g) Integration of 'hard' and 'soft' evaluation elements

According to the list of weaknesses, I can recognize that an evaluation process is a complex and a multidimensional phenomenon. The research problem is formulated by considering these weaknesses. However, I recognize that listed limitations are not realistic to solve in a single research.

The importance of evaluation as a part of a decision-making process is generally recognized. Therefore, organizations should use evaluation before acquiring or hiring packaged applications. Besides the purchase or hire of applications, applications are quite often modified before implementation, and modifications are carried out by applying stakeholders' requirements. If an ex-ante evaluation is carried out before purchase, hire or modification, I argue that results of an evaluation can be useful, when considering alternative software. This problematic situation is

the extremely important matter in public organizations, since the law of competition in European Union and its member states that organizations cannot purchase or hire applications without organizing competitive bidding between suppliers beforehand. What is important to recognize, is that participating companies are allowed to get evaluation criteria before sending offers, thus public organizations have to identify evaluation criteria and apply these on the decision making process, otherwise participating companies can ask why decisions are not carried out according to evaluation criteria. The situation pays attention to an evaluation process and an evaluation process should be regularly organized in an ex-ante situation. It is worth noting that exceptions exist in reality, when the available budget for purchasing or hiring or developing an in-house application is limited, then it is not necessary to arrange competitive bidding. However, I suggest that it is good to carry out an evaluation in this case too.

A particular Finnish university of applied sciences (UAS) is the case organization, which is used to demonstrating the evaluation method for a virtual learning application's ability to produce evaluation information for the decision-making process. The organization is located in the southern part of Finland and the number of students are over 7.000 and members of staff are 800. The UAS offers over twenty degree programmes and it "has units in seven locations within a 100 km area of range. These units specialized in areas, culture; natural resources and the environment; natural sciences; social sciences, business and administration; social services, health and sport; technology, communication and transport; and vocational teacher education." (Hamk, 2011) The case is limited to, a single degree programme, not a specified unit or the whole UAS.

The researcher's role in this evaluation process is twofold; the role of an evaluator and the role of an observing researcher. The role of researcher underlines that the main interest and the aim of this study is to have a deeper understanding of an evaluation process. From the theoretical and conceptual point of view of the research problem it is how to develop an evaluation method, which is based on Information Systems evaluation methods. The role of an evaluator combines theory and practice so that it is possible to carry out a demonstration process to validate that the developed evaluation method for a virtual learning application can be used to produce proposals for the decision-making process.

The research area belongs to two sciences, Information Systems and Education. Available evaluation methods of Information Systems are surveyed to specify which kinds of evaluation methods are available, and how I can try to develop an evaluation method for virtual learning application based on existing evaluation methods. From the education point of view, learning is explored to find out how features of the learning model are identified and how these features can be converted to objectives of evaluation and further to use evaluation criteria for a virtual learning application, when I try to develop an evaluation method for virtual learning application.

When I consider if any standards, that should be explored, exist, I point out that two standards can be recognized. The first standard is the Learning Object Metadata standard. The standardization process is ongoing and the current version of the Learning Object Metadata (LOM), IEEE-1484.12.1-2002, which is sponsored by the Learning technology Standards Committee of the IEEE (2002. The second standard is the Sharable Content Object Reference Model (SCORM). The SCORM development started 1999 initiatives of the Department of

Defence (DoD) of United States in the strategic plan. The SCORM is a collection of standards and specifications. The main objective of the Learning Object Metadata and the Sharable Content Object Reference Model is to support the reusability and interoperability in the context of online learning.

The main purpose in this study is to develop an evaluation method for a virtual learning application and not to explore online or virtual learning contexts, thus these standards are not explored in detail in this study. However, standards are recognized, since virtual learning applications exist that are developed based on these standards.

1.2 Description of a learning process

In this section, I survey how other researchers are described learning. The purpose of this section is to provide a basis for learning concepts. However, I believe that it is worth investigating some learning models and methods that are presented in other studies together with information and communication technology in learning. In higher education, learning and teaching is based on available data, information and knowledge connected to the specified context. These three terms are essential, when I describe learning. The knowledge can be divided into predictability knowledge, intelligence and wisdom as types of knowledge.

1.2.1 Knowledge and learning

In the learning process, a learner uses data, information and knowledge. Tuomi (1999) suggested that the conventional view on the knowledge hierarchy: data, information and knowledge should be explored in a reversed way. Tuomi (1999, p. 9) argued that before a learner can use data or information he or she has to have knowledge about reality. A learner uses knowledge by articulating, verbalizing and adding structure to get information, and a learner uses information by fixing, representing and interpreting for creating data. Tuomi stated that the reversed hierarchy is better than the conventional hierarchy, which is assumed to describe relationships between data, information and knowledge. I point out that e.g., considering the vocabulary of the c-language it is true that reserved words are understandable after a reader has some basic knowledge about c-language. However, I think that the conventional hierarchy is useful, when a researcher is constructing a description of a phenomenon.

Information Systems researchers Leidner and Jarvenpaa (1995) investigated learning and identified a set of learning models, which are applied to other researches. Cheetham and Chivers (2001) have investigated virtual classrooms and a virtual learning environment in adult and vocational learning and teaching. Leidner and Jarvenpaa's research is cited in many research papers, even Cheetham and Chivers critized it. However, I think that it is worth noting both studies in this thesis. Li (1997) and Khalifa (2001) utilized Leidner and Jarvenpaa's research, when they studied learning in the virtual learning environment.

Biggs and Collis (1982) explored learning processes and developed SOLO taxonomy, which utilized, when I try to identify roles of quantitative and qualitative knowledge in learning. I believe that classifying knowledge to quantitative and qualitative knowledge and recognizing learning processes; I can identify needed properties of a virtual learning application and use these properties to define evaluation criteria for a virtual learning application.

Kolb's (1984) experiential learning cycle includes interesting learning styles, which should also be taken into account when I try to develop an evaluation method and include individual learning styles as a part of evaluation criteria in an evaluation method. Kolb (1984) developed the experiential learning theory based on works of Dewey's philosophical pragmatism, Lewin's social psychology and Piaget's cognitive development genetic epistemology. Kolb et al. (1999) offered reasons why the concept 'experiential' should be used. The first reason is that learning is based on a learner's experience and the second reason is based on experiential works of Dewey, Lewin and Piaget. The experiential learning cycle is a process, which includes four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. The experiential learning cycle's stages demands that the learner makea a choice on how to handle abstract and concrete things, and to solve this Kolb identified learning patterns, which are named learning styles. Invented learning styles are diverging, assimilating, converging and accommodating.

I recognized that Leidner and Jarvenpaa used the term a learning model, not a learning method. I point out that the appropriate term is a learning method; however, this is a question of semantics. Cheetham and Chivers (2001, p. 282) present their learning mechanism for informal learning or professional learning. It is interesting to know that they present the learning mechanism (a learning method that I prefer to use as a concept) using the word "professional" as a mnemonic. I point out that Cheetham and Chivers are discussing the informal learning processes, while I amI am discussing the formal learning processes. However, their work is useful for this research in the context that the teaching at a polytechnic is a practice oriented and the curriculum context should include practical oriented learning periods.

Savery and Duffy (1996, p. 136) identified that the constructivism as a philosophical view can be characterized the following primary propositions:

1. Understanding is in our interactions with environment,
2. Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned,
3. Knowledge evolves through social negotiation and through the evaluation of the viability of individual understanding.

Savery and Duffy developed a set of instructional principles that can be used as a guide, the practice of teaching and the design of learning environment. The instructional principles are the following:

1) Anchor all learning activities to a larger task or problem,
2) Support the learner in developing ownership for the overall problem or task,
3) Design an authentic task,
4) Design the task and the learning environment to reflect the complexity of the environment, they should be able to function during and at the end of learning,

5) Give the learner ownership of the process to develop a solution,
6) Design the learning environment to support and challenge the learner's thinking,
7) Encourage testing ideas against alternative views and alternative contexts,
8) Provide the opportunity for and support reflection on both the content learned and the learning process.

1.2.2 Lifelong learning

The concept 'lifelong learning' is defined as early as 1960s. The concepts of formal education, non-formal education and informal education are proposed by Coombs et al. (1973), when they investigated how to arrange rural children and youth learning possibilities. Rogers (2004) identified non-formal and informal education and proposed that the concept flexible schooling between formal education and participatory education could solve the problem, which is recognized in Coombs et al.'s studies. Rogers offers a solution for the problem by suggesting extended learning continuum: formal education – non-formal – participatory education – informal learning. I agree with Rogers that the boundaries between formal - non-formal – participatory education - and informal learning are not clear one.

Education ministers of OECD countries agreed to develop strategies for lifelong learning for all (OECD, 1996). In 1990s, the concept of lifelong learning was accepted as a learning policy and/or programme all over the world. European Union has accepted a programme for lifelong learning 2007 - 2013 (The Decision establishing the Lifelong Learning Programme was published in the Official Journal of the European Union L327/45 on 24 November 2006.)

Werquin (2007) analyzed existing concepts when he prepared a discussion paper for a recognition programme in the European Union and according to him, I can state that formal education is the initial education and training system which leads to a qualification (learner can receive a certificate). The non-formal education is an organized learning process but outside the formal sector, it is planned with intentional activities, no learning objectives. This informal education is a true lifelong learning process with an unintentional learning process.

According to OECD (2007), "formal learning can be achieved when a learner decides to follow a programme of instruction in an educational institution, adult training centre or in the workplace. Formal learning is generally recognized in a qualification or a certificate." The concept informal learning is defined as "informal learning results from daily work-related, family or leisure activities. It is not organized or structured. Informal learning is in most cases unintentional from the learner's perspective. It does not usually lead to certification." OECD (2007) definition of "non-formal learning arises when an individual follows a learning programme but it is not usually evaluated and does not lead to certification. However it can be structured by the learning institution and is intentional from the learner's point of view."

I agree with Werquin that OECD's definition includes both formal and non-formal learning concepts, thus the learner's point of view this definition makes it possible that a learner can achieve the qualification following a programme either education institution or adult training

centres. Nevertheless, a learner can participate in education/training without achieving the certificate. From the learning perspective, formal, non-formal, and informal learning are concepts, which emphasize a learner's role in the learning process. A learner can decide how he or she is willing to acquire and create knowledge. The formal, non-formal and informal education, are concepts connected to society's role and the educational institutions' role in teaching. If I consider how virtual learning environment and applications can help the learning process, I can say that the virtual learning environment, and virtual learning applications make it possible to learn any place, any time and with or without tutoring . Educational institutions, adult training centres and workplaces and different types of hobby organizations can provide information and learning materials whose learners can utilize via the Internet.

I try to figure out how a lifelong learning concept and the sub-concepts are possible to be linked to each other. In Figure 1.1, arrows from educational institutions, non-formal educational/training centres and workplaces denote information and learning materials flows. A virtual learning environment and its applications are included to Figure 1.1 to show learning at any place and at any time. When I consider informal learning, then I can say that the Internet is a virtual learning environment, which is available for all. This possibility is true, where the network and computers are connected to the network. At the individual's perspective formal, non-formal and informal learning describe learning continuum. Formal education (policy and programme) is organized mainly by public organizations compulsory schools, secondary schools and universities and polytechnics. Non-formal education/training can be arranged in commercial and partly publicly maintained educational centres. Virtual learning environments and its applications are in the figure included between institutions and individual learning concepts to denote that learning is possible to organize by utilizing the Internet and computers.

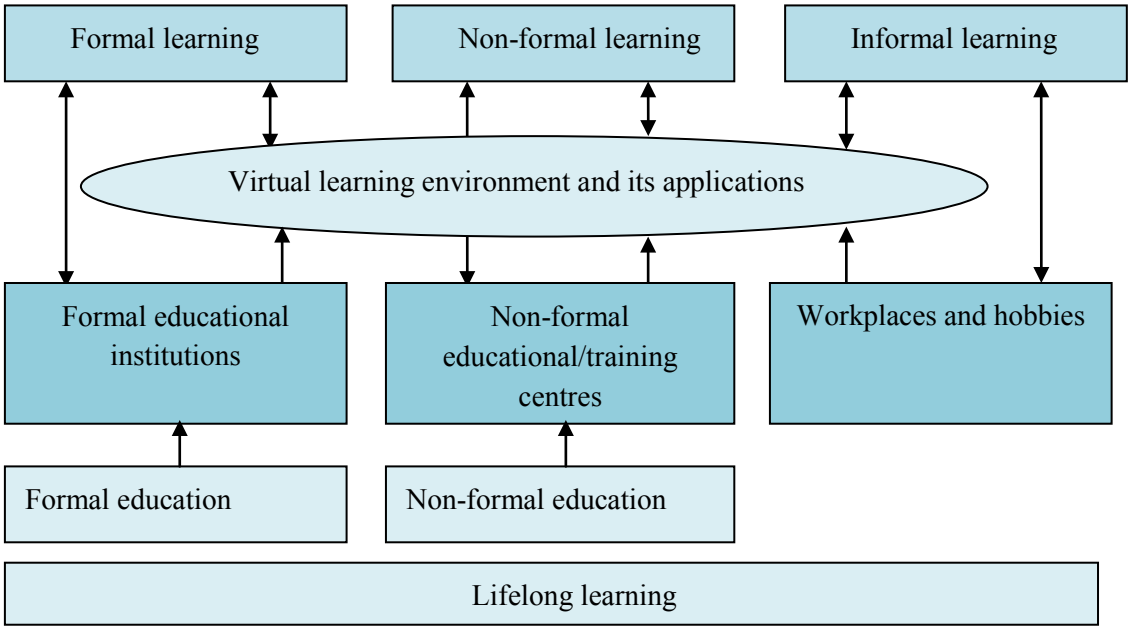

Figure 1.1 The lifelong learning concepts and educational institutions

In this study, I will use mainly concepts formal, non-formal and informal learning, when I consider a lifelong learning and virtual learning environment from the learner's perspective. When it is necessary to analyze educational institutions, I can use the concept of formal education to emphasize the role of educational institutions.

It is interesting to recognize that a concept of dialogue is a common underlying theme both in educational researchers (Aarnio and Enqvist's (2001) and Laurillard (1993), and in information technology researchers (Brigg et al. (1999) and Nunamaker et al. (1997). On the philosophical point of view, I point out that Hintikka (1982) presented a dialogical model of teaching, which was called 'a simple language-game'. Hakkarainen and Paavola (2007) presented the trialogical inquiry, inspired by Hintikka's model. This concept is constructed based on the acquisition, the participation and the knowledge creation metaphors. Britain and Liber (1999) utilized Laurillard (1993) research, when they developed an evaluation method for virtual learning environment.

While I take into account that teaching and learning is mainly based on written materials, discussions are also important, and thus I can argue that a usage of a virtual learning environment, dialog should be considered as an important object, when developing criteria of evaluation methods. A shared knowledge by dialogue between human beings used in learning models at higher educational organizations emphasizes that discussions together with printed learning material are essential to be taken into account, when identifying requirements and preferences for evaluation criteria for an ideal learning environment as a whole. In virtual learning environments chat, discussion forum and email are identified as a typical dialogue tool.

1.2.3 A problem based learning

In this sub-section, I explore shortly problem based learning. The main purpose is to identify, what the features of problem based learning are. Problem based learning and its modified version are explored as a learning method, when I try to develop evaluation criteria for virtual learning application based on the learning method.

The problem based learning method has been developed in the University of McMaster in Canada at the medicine and healthcare department during 1970 -1980 (Boud and Feletti, 1999). The McMaster's problem based learning includes the following features:

1) Learning is student centred,
2) Learning occurs in small student groups
3) Teachers are facilitators or guides
4) Problems form the organizing focus and stimulus for learning
5) Problems are a vehicle for the development of clinical problem solving
6) New information is acquired through self-directed learning.

After the original problem based learning method was developed, it has been modified, so there exist many modified variations of problem based learning. One of the modified methods is a collaborative problem based learning method (CPBL), which is selected to represent a learning method in this study and the CPBL method is utilized, when I develop an evaluation object and

evaluation criteria for the virtual learning application. Problem based learning is described by identifying seven or eight steps. The following list includes eight steps:

1) Clarifying the concept,
2) Defining the problem,
3) Analyzing the problem,
4) Systematic classification,
5) Formulating the learning objective,
6) Self-study, and
7) Post discussion,
8) Reflection (proposed step, as to fulfil learning process).

Poikela (2003) and Alanko-Turunen (2005) have studied problem based learning methods in Finland. Reflection is argued to belong to the second session and it is essential, because the result of evaluation of the learning is missing and important feedback cannot be gathered. The step includes self-, group- and tutor's reflection and a general session evaluation (see Alanko-Turunen, 2005).

According to Boud et al. (1985), problem based learning can be described by the following features:

- The presentation of a problem as the start of a learning process
- The presentation of learning problems in as realistic ways as possible in an educational setting
- The organization of learning processes in response to the problems
- The emphasis on student responsibility and initiative in learning
- Better accommodation of individual students' state of knowledge and experience at the starting point of learning
- More scope for integrating multi-disciplinary considerations, and
- More collaborative relationship between students and teachers in the learning process

It has been recognized that problems can be classified by using two dimensions. We can create problems that are either simple or complex, or the problem can be identified by using structure of the problem. The problem can be well-structured or ill-structured. Jonassen and Hung (2008) emphasized that difficulty of problem and structure of the problem play a key role in the effectiveness of learners' learning outcomes.

Alanko-Turunen (2005, p 78) has pointed out "the collaborative knowledge construction process requires that participants create a common social ground for information sharing." Learners have to ask questions and provide clarification in order to achieve learning goals. It can point out that group learning demands negotiation skills. According to Alanko-Turunen (2005, p. 217), the discussion of learning sessions (tutorial discourse, the term used by Alanko-Turunen) she identified the following:

a) The discourse of received knowing,
b) The discourse of diverse ways of knowing and being,
c) The discourse of emerging knowledge construction

1.3 Description of the virtual learning environment

In this section, I describe the concept of virtual learning environment and its components. The virtual learning environment and its one component a virtual learning application is a study object, so I think it is essential to identify and describe what these concepts include in this research.

In this research, the term education is used, since our case organization is a formal educational organization. Tammelin (2004) presents, in her study, the following concept: a) Network based teaching and points out that this concept is teacher-centred. I can argue that by changing it to the network based learning, then the concept can be learner centred, since student-student discussions are learner centred. b) Telematic based learning or teaching is a concept that French researchers used first according to Tammelin. The concept – "telematic" points out that telecommunications are used as a tool to mediate knowledge between sender and receiver. As Tammelin argues these concepts are depending on time, how the concepts are used in education. Computer Based Training (CBT) - denotes training or instruction, where a computer program is offering feedback in place of a live instructor, when course content is provided for explanation and clarifying examples. At the beginning CBT courses was developed for to deliver the course material and instructions via CD-ROM. Nowadays, the course materials are available via local area network and/or via the Internet. The basic idea for creating computer based training courses was that course instruction and course materials can be re-used. The course materials and instructions were created by team, which included facilitators, tutors, and designers. The term Computer Based Learning (CBL) is also used as a synonym for Web Based Training (WBT).

While considering why e-Learning is an interesting research area, I point out that at the beginning of 2000, the Commission of European Union launched the 'e-Learning' initiative to speed up the adjustment of education and training in Europe to the digital age in 2000. The initiative includes two actions: the aim of the first action was to start a lifelong training program for the use of new technology in education during 2000-2006, and total budget of €3.520 million; the second aim was "Europe must speed up the entry of its schools and other places of learning into the digital age. One of the objectives of eEurope initiative was to make digital literacy one of the basic skills of every young European. eLearning is intended to implement the education/training part of Europe." (IP-00-234). In this initiative, terms 'eLearning' and 'eEurope' are launched. The meaning of the term 'eLearning' is to use new multimedia technologies and the Internet in education. The purpose is "to improve the quality of learning by facilitating access to facilities and services as well as remote exchanges and collaboration" (http://www.europainfo.info). The initiative has four components a) to equip schools with multimedia computers, b) to train European teachers in digital technologies, 3) to develop European educational services and software and d) to speed up the networking of schools and teachers (IP-00-234). The Working Party for Education and Training has developed topics for education and adoption of new technology on different levels of education and lifelong learning. They named five areas where research is needed and one of these topics is the evaluation of methodologies and techniques. They defined it as follows:

"Research is needed into evaluation methods and technologies that permit the assessment of the effectiveness of eLearning solutions; support the learner's progress; and provide methods of accreditation and award of qualifications for eLearning in the context of learner mobility and lifelong learning." (ISCT, 2001).

The term '*eLearning*' is launched as a promotional concept, and it is used as an umbrella concept. This term seems to have different meanings in Europe and in USA. The Commission of the European Union launched the '*eLearning*' term at the initiative in 2000. In the USA, the current term 'eLearning' is written differently without a hyphen and different training organization denotes letter e with different meanings. Conner (2008) has presented that the letter 'e' can denote the following meanings: a) electronic, b) experiential, c) economical, d) ethereal, e) easy, f) executive, g) effective, h) eclectic, i) emerging and j) engaging. However, I point out that letter "e" denotes information and communication technology (ICT) that is used for learning and teaching. The commercial educational (training) organizations use the term for training instead of learning. Hundreds of virtual learning applications can be found in Finland and thousands all over the world. E-learning (virtual learning) applications can be identified as belonging to two main classes: a) commercial applications and b) Open Source applications.

The definition of E- learning including ICT can be defined as the following: "E-learning is the utilization of ICT in learning in order to acquire, store, and process information." And "as well as to develop these ICT utilization abilities when the learner acts, in reality, observing, contemplating, communicating, acquiring and exchanging information, as well as in this reality getting and exchanging experiences by using his/her know-how in everyday work and leisure activities." Koponen (2008, p.15) I point out that Koponen uses the term 'E-learning' while 'e-learning' is also used. I agree with Koponen's definition of e-learning. The definition identifies how learning and ICT can be combined together in learning process. The definition includes also everyday work and leisure activities, which can be seen as a part of an unconscious learning process and thus as an informal learning.

The term 'e-Learning' is used as a synonym for distance learning, since distance learning existed earlier than the "e-Learning" term. Distance learning means that learners and teachers are not at the same place and learners have access to learning material at a different time. The term 'Network learning' is also used as synonym for 'e-Learning'.

Currently there exists a new term 'blended learning' and according to the e-Learning Centre, it is a mixture of personal learning and e-learning. The American Society for Training and Development (ASTD) offers a similar definition. The term 'blended learning' is "learning events that combine aspects of online and face-to-face instruction." Graham (2008) represented the following definitions: Blended learning is combining instructional modalities, Blended learning is combining instructional methods, and blended learning is combining online and face-to-face instruction. Valiathan (2002) identified that the term "blended learning" is used to describe a solution that combines several different delivery methods, such as collaboration software, Web-based courses, the electronic proposal submission system (EPSS), and knowledge management practices. The concept is used to describe learning that mixes various event-based activities, including in person classrooms, e-learning, and self-paced learning. According to these definitions, the blended learning uses different types of media and learning

instructions from course instructors used via the network or the Internet and at the same time learners can accept instructions in the classroom. According to ASTD, the virtual classroom means “the online learning space where students and instructors interact.”

The literature review above revealed that the content of education and ICT-reliant learning environment is full of slightly different definitions. E-learning, online learning, virtual learning, blended learning, computer based training, and Web-bases training is used to describe learning in which ICT support exists. For this study, it is necessary to define, what I mean by virtual learning and virtual learning application as a sub-component of the virtual learning environment.

In this research, the term virtual learning is *a session, in which learners and teachers (including facilitators and tutors) are taking part and are together analyzing learning problems, identifying learning objects and trying to solve a problem by utilizing virtual learning application as a tool. Virtual learning may happen in the classroom and via network (including the Internet).*

The concept of virtual learning application *is a server-based application that is used receiving and transmitting learning instructions and learning material between tutor and students and students can share their own digital material using a virtual learning application as a tool.*

The concept of a virtual learning environment *is a wider concept than a virtual learning application; it means that a virtual learning environment is defined in this study as a general virtual learning system*.

The purpose of this study is to develop an evaluation method for virtual learning application, thus it is essential define*, that a virtual learning environment includes hardware such as servers, workstations, network devices, peripheral devices and networks, and it includes software such as operating systems, database systems, and it utilizes the Internet services and browsers. A virtual learning environment includes a virtual learning application, learning management systems, content producing and content management system.*

The virtual learning environment is described by identifying its components, and in this way, I have identified that a unit of analysis in this study is *an ideal virtual learning application*. A need for the concept 'an ideal virtual learning application' arose, when I investigated properties of virtual learning applications, and I found out that list of required properties include features that may be impossible to fulfil on a single virtual learning application. However, in an ex-ante evaluation process I can utilize all features of an ideal virtual learning application and by this way try to provide a richer picture of a virtual learning application.

1.4 Research framework for evaluation

In this section, I explore how evaluation projects between software evaluation projects and commercial off-the-shelf based system evaluation projects can be identified and what are the main differences between these two evaluation projects. It is interesting to notice that E-learning communities in Europe and in the USA have developed and used their own evaluation methods.

Early evaluation methods in universities in Europe and USA have used qualitative evaluation methods, in which the defined evaluation criteria scale is most often yes/no.

1.4.1 Evaluation in Information Systems

Evaluation research as a research subject in Information Systems can be explored by reviewing the MIS Quarterly Doctoral Database (2008) and searching by using the keyword: 'Evaluation'. The results of search returned 126 Ph.D. theses, in which the word 'Evaluation' is used in their title. The Doctoral Theses are documented from 1971 - in the MIS Quarterly Database. The MIS Quarterly Database does not directly include any similar study, which is used in this study and the subject is rare in the database. Nevertheless, that the MIS Quarterly database is not exhaustive for the evaluation theses from all over the world, I found according to calculation 2007, that there are Ph. D theses from Australia (2) Canada (2), Finland (1), Netherlands (1), India (1), United Kingdom (6) and USA (113). However, I point out that by searching evaluation from MIS Quarterly database does not mean that searched studies are comparable with this study, since meaning of the term 'evaluation' can be used in varied meanings and research objects can be different compared with this research object.

Evaluation projects can be divided to the three categories:
a) a software development project evaluation,
b) a commercial off-the-shelf product evaluation project and
c) a commercial off-the-shelf based system evaluation.

Comella-Dorda et al. (2004, p. 6) identified that differences between software development projects and commercial off-the-shelf based system evaluation are "... the simultaneous exploration of the system context, potential architectures and designs, and available products in the marketplace." While in software development evaluation projects, an evaluator can follow traditional software development evaluation. Evaluation methods are in many cases developed for software projects, and the purpose has been to explore, what are the factors that can be identified and which can be used to estimate software projects success or failure.

Commercial off-the-shelf software evaluation methods are developed starting from 1990, and one generally cited evaluation method is Kontio's (1995) OTSO-method. Wanyama and Far (2008, p. 35) identified the challenges associated with evaluation and selection processes:

1. Generation of high-level information used for decision-making,
2. Need for hierarchical decision-making processes,
3. Many similar commercial off-the-shelf software evaluation methods (products),
4. Multiple commercial off-the-shelf software selection objectives,
5. Changing commercial off-the-shelf software due to updates,
6. Multiple stakeholders,
7. Management information for the current and previous commercial off-the-shelf software selection processes, and
8. Selection of commercial off-the-shelf software for the different sub-system

Jadhav and Sonar (2009) explored evaluation studies including both software projects and commercial off-the-shelf software. Jadhav and Sonar concluded that software evaluation is multiple criteria decision-making problem (MCDM) and listed the following features:

"1) Analytic hierarchy process has been widely used for evaluation of the software packages,

2) There is a lack of a common list of generic software evaluation criteria and its meaning,

3) There is a need to develop a framework comprising of software selection methodology, evaluation technique, evaluation criteria, and system to assist decision makers in software selection."

As a conclusion of evaluation methods based on described literature reviews, I can state that the analytic hierarchy process (AHP) can be applied in this research and that a generic list of evaluation criteria that can be applied does not exist. I agree with Jadhav and Sonar that a framework is also needed in this research.

1.4.2 A design research framework

By considering, how design research approaches are appropriate for evaluation research, I pay attention to Järvinen's (2007a, p. 51) six fundamental features of design research. The first feature is "DS-1: Design science solves construction problems (producing new innovation) and improvement problems (improving the performance of existing entities)". The second feature is "DS-2: Design science produces design knowledge (concepts, constructs, models, and methods)." The third feature "DS-3 Building and evaluation are the two main activities of design science." the fourth is "DS-4: Design science's products are assessed against criteria of value or utility." The fifth is "DS-5: Design science research is initiated by the researcher(s) interested in developing technological rules for a certain type of issue. Each individual case is primarily oriented at solving the local problem in close collaboration with the local people." The sixth feature is "DS-6: Knowledge is generated, used and evaluated through the building action."

By exploring, how I can apply Järvinen's investigation for an evaluation research, I pay attention to DS-3. This can be used as a guide when building an evaluation method and can demonstrate whether the developed evaluation method is applicable for the specified evaluation problem. The feature DS-4 points out that a research should check if the developed evaluation method is usable for an evaluation process. The DS-5 emphasizes that researcher can apply the technological rules, when trying to produce an evaluation method, which can be used for producing suggestions and proposals for decision-making process. The DS-6 pays attention to how it can be used available knowledge, when building an evaluation method for a virtual learning application.

By analyzing approaches of evaluation research framework, I selected a general structure of the design research process and it is described in Figure 1.2. Vaishnavi and Kuechler (2008a) proposed the general structure of design research as a possible framework to utilize in design research work. I emphasize that Kontio's OTSO method is also a promising method to utilize and Peffers et al.'s (2008) design science research method (DSRM) is usable too. However, I

selected Vaishnavi and Kuechler's method to use as a basis for an evaluation method for a virtual learning application.

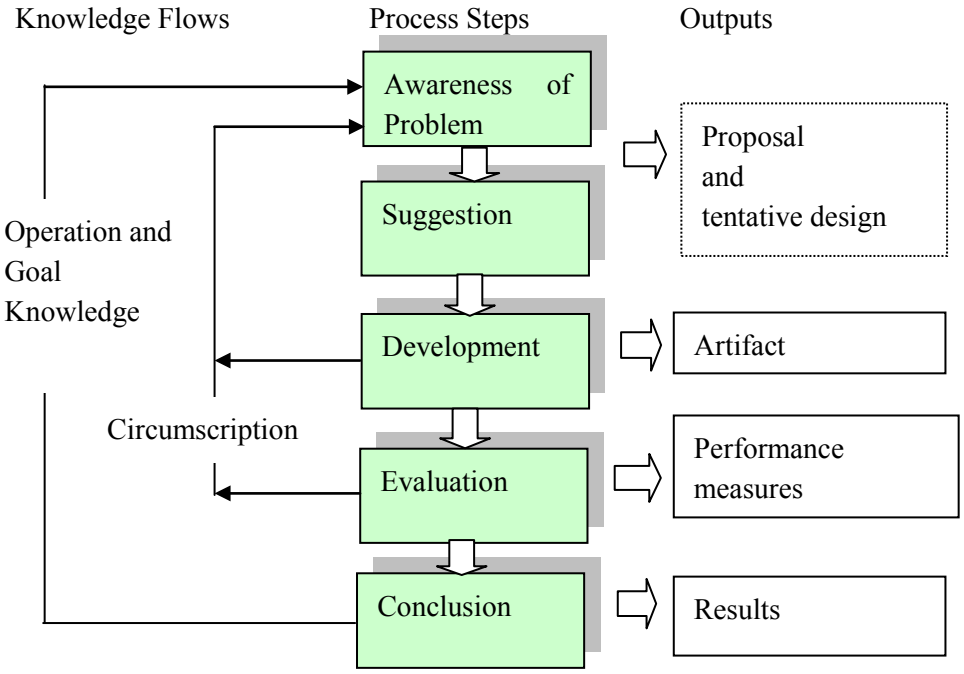

Figure 1.2 The general methodology of design research (Vaishnavi & Kuechler, 2008)

The first stage is to recognize an evaluation problem, the second stage is to write a plan how to evaluate and to propose one or two evaluation methods, which are possible to use during an evaluation process. The third stage in Figure 1.2 is the development, in which an evaluation method is developed and the output an artefact. It is good to remember that if we develop an evaluation method, then it is not an IT artefact according to March. However, if we follow what Orlikowski and Iacono (2001) proposed the term of IT artefact/artefact as the core of Information Systems' field and explore their premises (s.131): "1) ... IT artefact is designed, constructed and used by people. 2) IT artefacts are embedded in time, place, discourse, and community. 3) IT artefacts are usually made up of a multiplicity of often fragile and fragmentary components. 4) IT artefacts are neither fixed nor independent, but they emerge from ongoing social and economic practices. 5) IT artefacts are not static or unchanging, but dynamic." I argue that also an evaluation method can include these premises, so an evaluation method is an artefact. The fourth stage is the evaluation in the general methodology of design research and the outputs are performance measures. In evaluation research, this stage will be the demonstration, and the purpose is to show that developed evaluation method is usable before its actual use in an evaluation process. The fifth stage is a conclusion in which evaluation results, suggestions and recommendations are discussed.

1.5 The research objectives and research questions

In this section, I define research objectives and specify research questions. The main objective of this study is defined in two stages:

a) The first objective is to develop an evaluation method that is based on the criteria of the stakeholder groups, the selected learning method and the properties of an ideal virtual learning application. The calculations evaluation method are based on the analytic hierarchy process (AHP).

b) The second objective is to demonstrate that the specified evaluation method by using a single case and to show that the developed evaluation process model is usable for an evaluation process and the specified evaluation method for a virtual learning application is a tool to produce proposals for decision-making.

Also in this study, I try to understand the practitioners' attitude and motives; why it is difficult to utilize available evaluation methods or can other reasons be revealed why evaluation methods are not used.

This research is a multi-discipline study, as the main discipline is Information Systems and Education is utilized, when learning methods are identified and investigated. Education is important part of the research. I point out that if learning and teaching processes are described in general terms, then it is impossible to identify requirements and stakeholder's preferences, which can be used as the bases for evaluation criteria. The research objectives are converted to research questions:

RQ1: How can be developed a criteria based on a multi-attribute evaluation method and to use AHP methods to calculate evaluation outcomes that an evaluation process of a virtual learning application can be carried out and to produce results that are useful for decision-making?

In this study, the analytic hierarchy process method is utilized, when I demonstrate how developed evaluation method can be used. The analytic hierarchy method is selected, since it is generally applied to other evaluation methods. The AHP-method is based on Saaty's (2006) work.

RQ2: How to demonstrate the collaborative problem based learning evaluation processmodel?

Many evaluation methods are developed by using the specified programming tools for creating applications, and evaluators have to learn how to use evaluation method. The evaluation methods are available for a licence fee, which may be a reason that small and medium size companies or organizations are not willing to use the evaluation method. I try to identify the stakeholder's roles and how to measure the importance of the criterion in comparison to other criteria and how to measure each stakeholder group's impact on the decision making process.

1.6 The Structure of thesis

The thesis is structured into seven chapters**.** The structure is organized by following a typical evaluation process, in which an evaluation problem and evaluation criteria are identified, an evaluation method and metrics are selected and a stakeholders' evaluation method is specified. The specified evaluation methods are demonstrated to show that it is possible to produce usable

evaluation results. In Chapter 7, the achieved results are represented and scientific merits are discussed. Limitations and future research problems are also considered. The rest of the thesis is represented in Table 1.2.

Table 1.2 The structure of thesis

Research stages	*Ch.*	*Content and outcomes*
Defining an evaluation problem and identifying criteria	2 – 4	A research process and research area are identified. Learning processes are represented and virtual learning environment and learning method described. The research methodology of an evaluation method is described. Evaluation method is described and selected evaluation criteria are identified.
Developing evaluation methods	5	Developing an evaluation method of virtual learning application by using stakeholder theory, a collaborative problem based learning method and AHP-method. The criteria are based on the stakeholder's needs, learning method and properties of the application.
Demonstration evaluation methods	6	Selected virtual learning applications are represented. Description of demonstrated evaluation method. The results of evaluation methods are explored.
Conclusions	7	Conclusions and discussions of outcomes of the research are considered. A practical results and scientific contributions are represented. A possible future research question and problems are speculated.

Chapter two

2 A research framework and methodologies

In Chapter 2, I represent and identify the research area and develop a structure of development process, which I will utilize in this study. The structure of a construction process is based on the Vaishnavi and Kuechler's (2008a/b) general methodology of design research. In Section 2.1, the structure of development process is considered.

In Section 2.1, I create a structure of research framework, which I amI am using as a guide for this study. The framework of the research is based on a general methodology of design research. I visualize, how a single process or a phase of general methodology of design research can be constructed by applying a general phases to the evaluation process.

In Section 2.2, I describe and analyze methodological approaches that are used in Information Systems research. The research is identified belonging to design science and the approach according to Järvinen's (2004) taxonomy: 'researches stressing utilities of innovation' and its sub-category 'innovation evaluation approach'. By identifying a research approach category, the research domain is selected. Evaluation research processes are investigated by using the concept of a life cycle of an artefact. I identify that the evaluation process can be carried out ex-ante, ongoing and ex-post phase in the life cycle of an artefact. This study is an ex-ante evaluation, since the main purpose of the research is to produce proposals and suggestions of decision-making, when decision-makers are considering which virtual learning application should be selected.

In Section 2.3, I will explore the IT artefact and IT reliant work system as a research object. This exploration is mainly based on the Alter's (1999, 2003a, 2008) and Orlikowski and Iacano's (2001) research. The purpose is to show that to be able to develop an evaluation method for a virtual learning application it should be analyzed in the context of its use. I present an ontological basis of this research, and this is based on the Iivari's (2007) work, in which he points out that Popper's three worlds is a solid ontological base. By considering an evaluation process and the process for developing an evaluation method, I explore Hevner et al.'s (2004) design science process guidelines, Vershuren and Hartog's (2005) process method, Rossi and Sein's (2003) design research process and Kontio's (1995a/b) OTSO-method.

In Section 2.4, I try to show that a development process of an evaluation method can be based on the socio-technical approach and usage of Mumford's (1983a) ETHICS-method as a meta-method in this study.

2.1 Framework of the research process

A general framework of the development research process is described in Figure 1.2. The general methodology of design research includes the following activities: awareness of problem,

suggestion, development, evaluation and conclusion. A knowledge flow includes operation, goal knowledge and circumscription. Possible outputs are proposal and tentative design. Output of development activity is artefact. The evaluation is a single activity and outputs are performance measures. The output of conclusion is results of the research.

I try to build a structure of an evaluation research by applying the Vaishnavi and Kuechler's (2008a) general methodology of design research. The phases or steps in our structure are the following: 1) the identification of development problem and research method, 2) defining evaluation criteria, 3) developing the evaluation method, 4) demonstrating the evaluation method, and 5) possible results or outcomes, which can be a new evaluation method, improvements of available evaluation method(s), and failures.

Knowledge flows from outcomes to identification of development, and the research method includes a feedback and corrective suggestions that should be recognized when the evaluation method is used in the future. Operation and goal knowledge describe how the development process can be carried out and how goals should be recognized during the construction process. Time is an essential parameter in an evaluation process, e.g. ex-ante evaluation process, it is a limited resource and the evaluator has to follow time limits and try to achieve results at the time.

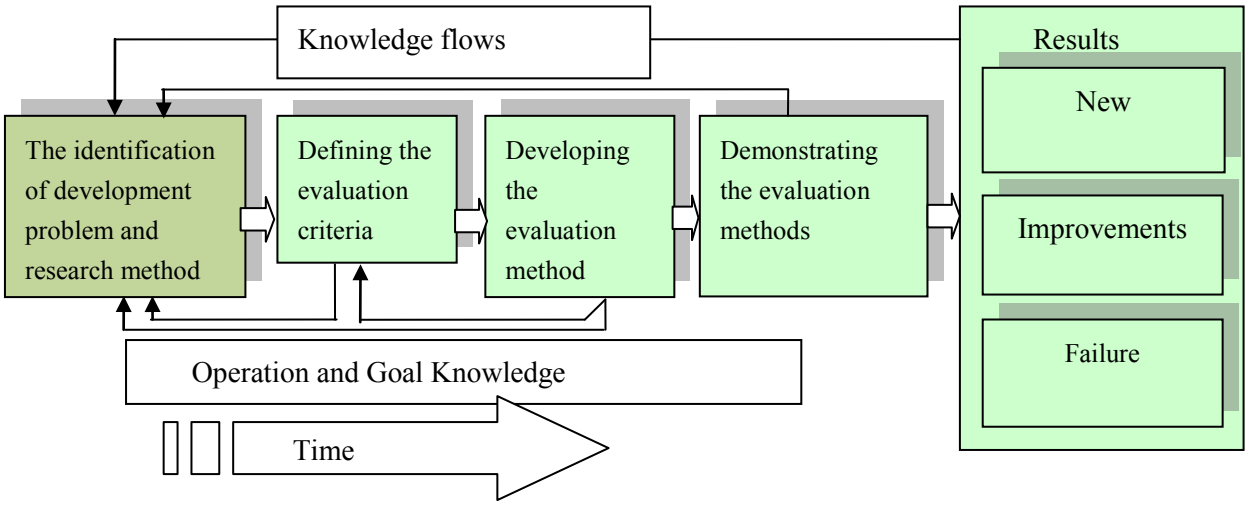

Figure 2.1 The structure of an evaluation research process

I point out that the structure of an evaluation research process in comparison to the general methodology of design research is a sub-variant. In the general methodology of design research, the evaluation and conclusion are the fourth and fifth steps, so I amI am constructing a sub-method of general methodology of design research.

By following Vaishnavi and Kuechler's argumentation (2008a), I can argue that the structure of an evaluation research process is developmental. It is a method for an evaluation research process. I point out that it is true that other descriptions of the design research process exist, (e.g. March and Smith, 1995; Rossi and Sein, 2003; Hevner et al.,2004). Järvinen (2007a, p. 53) pays attention to March and Smith (1995) and Hevner et al.'s (2004) recommendation for reporting successful research results, such as the constructions and the significant

improvements, while van Aken (2004) accepts that even moderate failures should be reported. However, I chose Vaishnavi and Kuechler's general methodology of design research to methodology that I apply in this study.

2.2 Methodological approaches in design research

According to Keen (1995) the concept of Information and Communication Technology (ICT) is accepted as an 'umbrella' term which means user-machine systems for providing data, information and knowledge to support daily operations and management and decision-making. Symons and Walsham (1988) write that the primary function of IT artefacts' evaluation is to contribute to the rationalization of decision-making. Lin and Pervan (2001a/b, p. 3) define IT artefact evaluation as "… the weighing up processes to rationally assess the value of any acquisition of software or hardware, which is expected to improve the business value of an organization's information systems". The main objective of this definition is that the evaluation process should produce rational values that can be used for decision-making.

A logical classification of research approaches is investigated in Järvinen's (2008) taxonomy, which is based on March and Smith's (1995) idea about research approaches. Siponen (2002), among others, used Järvinen's taxonomy in his study to clarify research approach and research questions. Järvinen's taxonomy describes in Figure 2.2 how the researcher should select an approach to apply for a study. The tree-like structure reveals this selection process in a logical way. When a researcher wants to study reality, he or she can decide to carry out one of the following research processes:

a) *the conceptual analytical research means to study reality, and to build a new theory or modify an existing theory,*
b) *a researcher can collect research data and build a new theory based on empirical situation,*
c) *a researcher can select to test available theories to a certain situation in reality by collecting research data and testing theory,*
d) *if a researcher wants to study an innovation, she or he can select to build an innovation, he or she can also evaluate available and interesting innovations by using evaluation approaches.*

The theory creating approach process may end in consensus with current theory and conforming existing theory and add some new features to the theory or the results may show that other results are possible. Deetz (1996, p. 197) emphasized that "Consensus or dissensus should not be understood as agreement and disagreement but rather as presentation of unity or of difference, the continuation or disruption of any prevailing discourse." Buchanan (2003) wrote that "One central research aim in studying organizational change processes should thus concern the exposure of competing narratives, polyvocality, contradiction, ambiguity, disagreement and uncertainty. - Competing narratives are naturally occurring phenomena, not aberrations to be triangulated away methodologically. Exposing competing narratives, including 'official' accounts and otherwise subversive and silenced voices, requires the use of a broad range of data

collection sources and methods, considering also the nature of the interpersonal relationships formed with respondents."

The main purpose of the study is to explore, how an evaluation method should be developed and to produce an evaluation method for an information application and evaluate its usability and performance. The unit of analysis is a virtual learning application, which is identified as an information application or system, which is a general name for an evaluation object to be evaluated. To clarify a research problem, I emphasize that it is useful to separate an evaluation process in three different processes: ex-ante, ongoing, and ex-post evaluation. The basic underlining assumptions are that slightly different evaluation criteria exist in an ex-ante, ongoing and ex-post evaluation. For this reason, the three evaluation processes are identified and these are included in Järvinen's taxonomy. The evaluation of information system before its installation and use are called ex-ante evaluation. The second evaluation (ongoing evaluation) should be carried out, when information system is installed and users are being used, and the third evaluation process is an ex-post evaluation, and is carried out when it is decided to remove information system from the active use. The evaluation methods that are used ex-ante, ongoing and ex-post evaluation processes are differentiated from each other by some properties (evaluation criteria).

Cronholm and Goldkuhl (2003a, b) propose that the objective of the evaluation methods can be identified in such a way that the objective of an evaluation process can be the following:

a) goal-free,
b) goal-based or
c) criteria-based evaluation method.

By following Cronholm and Goldkuhl's classification, the evaluation method can be based on the properties of virtual learning application, and an evaluator can decide to use a goal-free, goal based or criteria-based evaluation method. If I consider an ex-ante evaluation situation, then I argue that goal-based and/or criteria-based evaluation methods are recommended. Therefore, the evaluator can produce suggestions and recommendation for decision-making. A goal-free evaluation process can be used, when the purpose is to classify available virtual learning application, but no suggestions and recommendations are needed or expected.

March and Smith (1995) identified research activities in design science and natural science. They recognized an evaluation activity. The processes that can be included in the research activities are developing constructs, model, method and instantiation. Following March and Smith's model of how to create an evaluation method, I will identify concept sthat will be used to describe an evaluation situation and how to use reconginized concept to create an evaluation method for a virtual learning application.

The developed evaluation method can be evaluated by utilizing March and Smith's (1995) criteria: the fidelity, completeness, level of detail, robustness and internal consistency. If the evaluation method for virtual learning application meets the criteria, then I can argue that the evaluation method can be accepted at least for a scientific point of view. By considering if March and Smith's criteria are acceptable to practitioner point of view, I can argue that these should be accepted, when considering, how good an evaluation method is in the real situation. It

is worth noting that decision-makers can always accept or reject offered suggestions and recommendations, but the evaluation method can be useful per se.

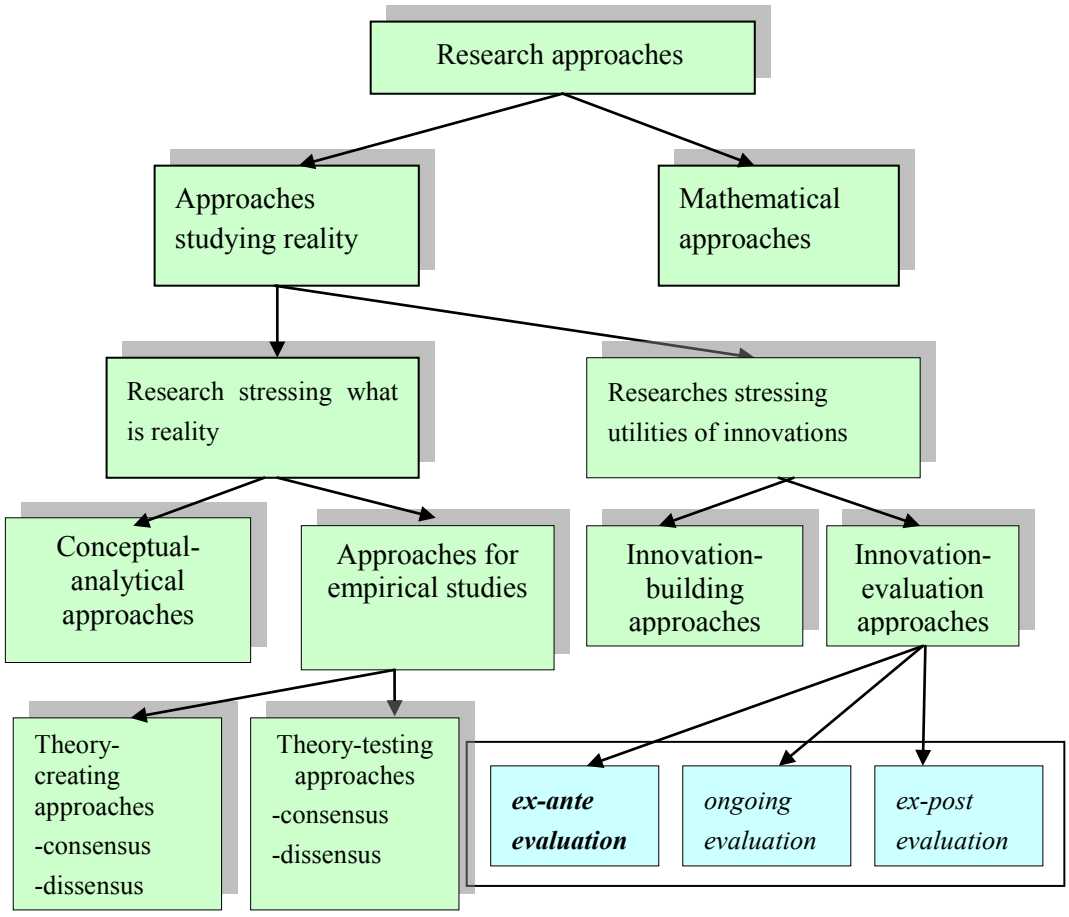

Figure 2.2 Modified taxonomy of research approaches (Järvinen, 2004).

In Figure 2.2, it is presented innovation-evaluation approaches divided to three different evaluation processes. The purpose of the modified figure is to show at the general level, how to set evaluation processes in three stages of the life cycle of information application or system. I point out that this thesis belongs to the innovation-building approaches in Järvinen's taxonomy.

2.3 The methodological background in evaluation research

In sub-section 2.3.1, I will explore how a study object virtual learning application can be identified by exploring existing research reports. First, I explore how a framework of an information system is identified, the second I explore how Alter (2003a) identify IT-system as an artefact, which should be recognized and how it should be connected to a work system, in which an IT-system is used. Benbasat and Zmud (2003) emphasized that an IT artefact should be explored and evaluated, taking into account its nomological net. The nomological net is the term developed by Cronbach and Meehl (1955), and it means construct validity. In addition, I consider how Orlikowski and Iacono (2001) proposed that an IT artefact is 'a core of Information Systems'.

In the sub-section 2.3.2, ontological background is explored based on the Iivari's (1991, 2007) ontological framework. In sub-section 2.3.3, I will explore design research process methods to specify that the structure of evaluation process method for virtual learning application be methodologically based on existing design science (research) methods.

2.3.1 IT artefact or IT reliant work system as a research object

The evaluation process consists of a set of activities that are carried out, when an evaluator is evaluating an information system. Before defining the evaluation as a research object, it was necessary to define what an "evaluation" means from an information and communication technology (ICT) perspective. Discussing information systems, the fundamental work of Langefors (1973) is considered, since he identified the concept of information using the infological equation, I = i(D,S,t), where D is data, S is an individual experience and t is time.

Langefors' infological equation and its use in an evaluation research is an open question. However, I try to suggest that data can be identified as learning material, individual experience can be specified by using learning method and learning styles, when I consider how learners may utilize different learning styles and available knowledge during the learning process. Time (t) had to be taken into account, since available virtual learning applications and applied learning methods are always time dependent phenomena. It is true that learning style is personal and it is difficult to change, so the learning materials and learning instructions should taken this into account.

Ives, Hamilton and Davis (1980) defined that the framework of an information system in organizations consists of the five environments:

a) the User environment,
b) the IS development environment,
c) the IS operations environment,
d) the Organizational environment, and
e) the External environment.

Ives et al.'s framework of information systems' environments: user, operations, organizational and external can be identified in a learning situation, thus these should be taken into account, when I amdeveloping an evaluation method. The information systems' development environment can be considered in a situation, in which a virtual learning application becomes a development project by utilizing an organization's own IT-staff and consultants. The use processes are in teaching and learning, so I should consider how these processes could be identified, when I am developing usable evaluation method for virtual learning application. The operation process could be identified, when I explore how ICT-staff can operate and manage virtual learning application and its environments.

According to Alter (2003a) "IT-reliant work systems should be the central focus of the IS field" and Alter identifies "IT-reliant work systems are work systems whose efficient and/or

effective operation depends on the use of IT". The central term of Alter's definition is "the work system" which includes environment, infrastructure, strategies, customers, product and services, work practices, participants, information and technologies. Alter proposes a work system framework that can be used studying an information system. Alter identified 18 reasons that support the use of IT-reliant work systems as a core subject matter, which should take into account in information research. However, Alter did not identify the IT-artefact as a core subject. Alter (2003a) also presents critical comments on the original DeLone and McLean (1992) IS success model, and he provides questions about the components of the model, asking, if the components are really valid for IT artefacts and represents the properties of the IT-reliant work systems. While Alter supports Orlikowski and Iacano's beliefs, on how to theorize and study the IT-field, he questioned Orlikowski and Iacano's (2001) proposal that IT artefact is the core of Information Systems. Alter proposes that an evaluation should be carried out using Cameron and Whetten's (1983) seven factors model of evaluation. These factors are:

1) the system,
2) the stakeholders,
3) the purpose of evaluation,
4) the measures,
5) the referent for comparison,
6) the time period, and
7) the informant.

The first factor system is a large component to try to evaluate as a single object. Seddon et al. (1999) recommended the use of the following dimensions:

a) aspect of information technology use,
b) a single application,
c) type of information technology or type of information application,
d) where information application or information technology is used (an organization or a single unit),
e) what methodology is used to during the development project of information system or information application and
f) what is the function of information technology or information system in an organization or in a single sub-organization. In this research case, evaluation object is a single application, and it is planned to use in a single sub-organization.

The second factor, stakeholders are in this research defined to include the following groups: a) students, b) teachers, c) ICT-staff and d) executives. The third factor, purpose of evaluation produces suggestions and recommendation for decision-making. The fourth factor, measures are in this case, an analytic hierarchy process (AHP) metrics. The fifth factor, referent for comparison is in this study the selected virtual learning applications, which will be evaluated, and other evaluation results are also reviewed, when I consider the results of an evaluation process. The time period is defined to be before decision-making (ex-ante evaluation). The evaluation data will be produced for demonstration by researchers and to the main purpose is to show that the developed evaluation method is usable. It is good to recognize that Seddon et al. (1999) used two factors: a system and stakeholders and created an evaluation matrix, which

included 5 * 6 = 30 classes of measures. If it is considered to take all seven factors in an evaluation process, then I can hit a situation in which evaluation matrix is a rather large and the results can be difficult to use and to report to decision-makers in a proper way.

When the research object is an evaluation method for virtual learning application in this case, I can explore Orlikowski and Iacono's (2001) premises, when I try to describe an evaluation process, and to decide what kinds of components I should include in an evaluation object. Orlikowski and Iacono (2001) proposed the following premises of IT artefact:

a) It is designed, constructed, and used by people and shaped by the interests, values, and assumptions, it is not natural, neutral, universal or given.
b) It always embedded in some time, place, discourse, and community.
c) It is usually made up of a multiplicity of often fragile and fragmentary components, whose interconnections are often partial and provisional and, which require bridging, integration, and articulation in order for them together.
d) It is neither fixed nor independent, but they emerge from ongoing social and economic practices. As human inventions, artefacts undergo various transitions over time.
e) It is a not static or unchanging, but dynamic.

Benbasat and Zmud (2003) emphasized that the Information Systems' core is an IT artefact, which should explore by taking into account the following: a) context(s), b) structure, c) task(s), which creates an environment in which IT artefact is used, and it should also be explored. IT artefact and its nomological net are described in Figure 2.3. Benbasat and Zmud identified the phenomena of IS studies and named these as the set of core properties:

a) IT managerial, methodological and technological capabilities,
b) IT managerial methodological, and operational practices,
c) the usage of the IT artefact and
d) the impact of the IT artefact.

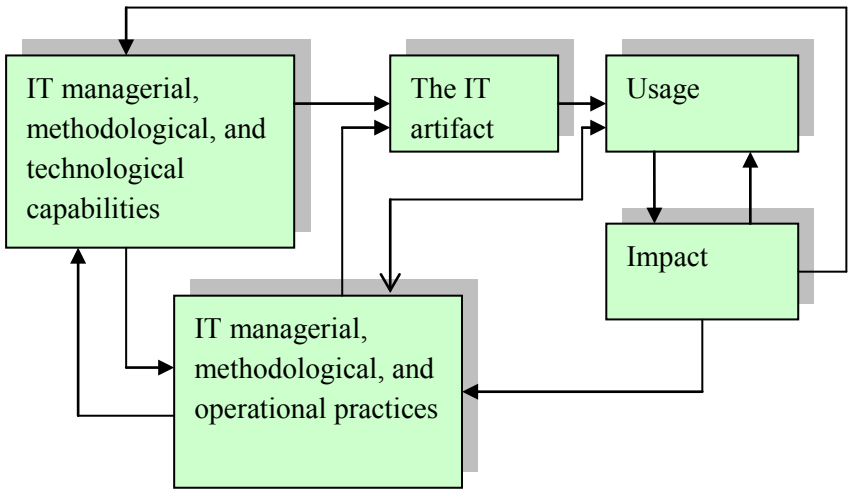

Figure 2.3 The IT Artifact and Its Immediate Nomological Net (Benbasat & Zmud, 2003, p.187)

The interesting matters that Benbasat and Zmud presented are the error of exclusion and the error of inclusion. They stressed that researchers should not exclude components that are essential for the study in question, or include components that are not needed in the research.

Agarval and Lucas (2005) offered a competitive method based on Benbasat and Zmud's concepts the error of exclusion and error of inclusion proposing that a better way is to try to answer the following questions:

> *"1) Is there a non-trivial aspect of underlying theory that draws upon the unique nature of the IT artefact?*
> *(2) Would the phenomenon have been approached differently was the IT artefact not involved?*
> *(3) Does the research illuminate scholarly and practitioner understanding related to the construction, management, and effects of the IT artefact?"*

Agarval and Lucas (2005) refer 18 articles in which Information Systems' research phenomenon and identity crisis of Information Systems are analyzed. Agarval and Lucas acknowledge the multidisciplinary nature of Information Systems, and they propose IS researchers continue studies that give a benefit to other disciplines emphasizing that Information Systems can become a reference science. I agree with Agarval and Lucas' proposal, since the purpose of a study is to produce proposals that are useful for the decision maker in an educational organization. Benbasat and Zmud emphasize, that the core of IS studies are artefacts. Agarval and Lucas' argumentation that Information Systems researchers are able to study a multidisciplinary phenomenon is also accepted.

Alter (2003b) proposes an alternative 'vision' and named it "systems in organisations" that IS researchers can follow, when carrying out IS/IT research. Alter (2003) continued discussion of a core object in Information Systems and represented 18 reasons, why an IT artefact is not alone a proper core object, but it should be placed on an organizational context in which an information system is planned to be used. Alter used the term 'business perspective', but I think the business perspective is too narrow, since IT artefacts are used in non-profit and public organizations, so I prefer to use the term organization.

Alter (2008) continued further, exploring in more detail, work systems and IT-reliant work systems. Alter argued that proper definitions help organize concepts, relationships and information by point out that defining information system as a work system can clarify what concepts and relationships between concepts and what kinds of information are needed, when I define a research object: a virtual learning application. Alter (2008, p. 456) considered systematic power and explanatory power and emphasized these roles, when I try to explain and predict a research phenomenon.

By summarizing the discussion of IS/IT identity crisis and what to study, it is possible to propose a selection from three alternative visions, how and what to study. The first vision is Benbasat and Zmud's IS/IT artefact as core vision', the second is Agarval and Lucas's 'IS/IT multidisciplinary vision' and the third is Alter 'systems in organization vision'.

To conclude with methodological background considerations, I can emphasize that a research object, virtual learning application should be evaluated taking into account the following elements:

1. A research plan includes Orlikowski and Iacono's premises that the research plan is based on a proper description of a research object.
2. A research plan includes Benbasat and Zmud's recommendations of IT artefact and its immediate nomological net.
3. A research plan recognizes Alter's work system in a way that virtual learning application is evaluated at the proper organizational environment and evaluation criteria include the important elements, which are represented in Alter's work system framework.
4. Cameron and Whetten's seven factors are included in an evaluation research plan that produced results taking into account: features of virtual learning application (system), requirements of stakeholders and metrics are selected in a way that it is possible to calculate reasoned and usable evaluation results.
5. According to Järvinen's taxonomy, an evaluation research belongs to research stressing utilities of innovation, and it will be specified to ex-ante evaluation research.

By recognizing these elements, I can identify a research object: an evaluation method for virtual learning application and specifying it based on design research theory. The main aim of this study is to develop an evaluation method for a virtual learning application, thus I need a methodological background for this developing process.

2.3.2 Ontological background in design science research

In design science research, the ontology for design research can be considered based on e.g., Popper's three worlds by utilizing Iivari's work. I consider shortly, what Iivari's (1991) ontological framework and its revisited version (2007) mean in this case study. Iivari analyzed ontology in design research, when he proposed his paradigmatic framework in 1991. Iivari continued to consider what ontology means in design research, and he revised in 2007 his own framework of design science. The original ontological framework consists of the following components (1991, p. 12): a) the view of information/data, b) the view of information/data system, c) the view of human beings, d) the view of technology, and e) the view of organization and society. Iivari proposed that research of an information system as design science should be based on Popper's (1978) three world framework epistemologies, which are conceptual, descriptive, and prescriptive knowledge. Iivari defined that his paradigmatic framework consists of ontology, epistemology, methodology and ethics of research (2007, p. 3). Popper's three worlds ontology is described in Table 2.1.

Table 2.1 An Ontology for design science research modified by (Iivari, 2007, p.4)

Poppers World	Research phenomena	Research examples
Nature (World one)	IT/IS artefacts and nature	Evaluation IT artefacts against natural phenomena
Consciousness and mental states (World two)	IT artefacts and consciousness and mental states	Evaluation IT artefacts against consciousness and mental states.
Institutions, Theories, and Artefacts that includes: IT artefacts, and IT artefact Applications, and Meta IT (World three)	IT artefacts and institutions IT artefacts and theories IT artefacts and applications, meta IT artefacts	Evaluation of organizational information systems New types of theories made possible by IT artefacts Evaluation of the performance of artefacts comprising embedded computing.

I stress that Iivari's archetypes are only general descriptions of IT artefacts. One can assume that it is possible to place one application type as a virtual learning application to only one category, but as revealed in Table 2.2, it can belong to many categories. The fact is that a virtual learning environment, as system, belongs to more than one category. This means that a virtual learning application can be constructed of different types of applications and some of these are described in Table 2.2. This argumentation reveals that a virtual learning application is a complicated artefact to evaluate with a single evaluation method. Evaluation methodology and methods had to be created so that it is possible to analyze and evaluate each sub - application differently and then summarize the results to one evaluation method.

Table 2.2 The archetypes of the IT artifact and virtual learning environment

Role and function	Metaphors	Examples	Virtual learning environment
To automate	Processor	Many Embedded systems Many transaction systems	Virtual environment may include automated processes that learners and teachers can utilize. (e.g. answers, help questions and test results)
To augment	Tool (proper)	Many personal productivity systems Computer aided design	Tools can produce learning materials and curriculum descriptions and instructions of a course used by facilitators and teachers.
To mediate	Medium	Email, instant messaging, chat rooms, blogs.	Asynchronous and synchronous discussion and messaging application, chat room

		Electronic storage systems (e.g. CDs and DVDs)	application, and quizzes application and an alternative e-mail, if other e-mails are not possible to use.
To inform	Information source	Information system proper	Tools to retrieve and download course materials, and to read it and to send feedback for students, tutors, and facilitator (teachers).
To entertain	Game	Computer games	Application for learning games
To artify	Piece of art	Computer art	Tools can be used to produce images and drawings. Preparing learning materials and to answer or to produce solution to learning problems.
To accompany	Pet	Digital (virtual and robotic) pets	Pets and robots can be used to emphasize learning processes.

The main purpose to describe a virtual learning environment in Table 2.2 is to show that it is complicated and a difficult research object as a whole. Therefore, in this study a research object is narrow, namely a virtual learning application. The descriptions include elements that are not defined in the definition of a virtual learning application. I emphasize that an ideal virtual learning application should include described elements, and then I can consider these elements, I try to develop an evaluation object and evaluation criteria for the virtual learning application.

2.3.2 Design science (research) process methods

By considering an evaluation process, which design research process methods are applicable, I take four process methods, which can be utilized in this study. The first is Hevner et al.'s (2004) design research guidelines and the second is Verschuren and Hartog's (2005) design science process method. The third method, which will be explored, is Rossi and Sein's (2003) design research process method. The fourth method of a design research process, which will be explored is Kontio's (1995) OTSO-method that was developed to evaluate component of commercial off-the-shelf software, thus it is an interesting option to explore, since a typical virtual learning application is a software package.

I recognized that Venable (2006) also explored how design science (research) theory and theorizing representing existing methods of a design research process were developed. Venable proposed that design theory is a utility theory, which can be expressed by using solution space and applying utility theories and achieving solution space (see Venable, 2006, p.13). Venable pays attention to Walls et al.'s (1992); Nunamaker et al.'s (1991); Rossi and Sein's (2003),Vaishnavi and Kuechler's (2008a) articles, when he considered how design research process methods have been explored and developed. However, I do not explore in detail Venable's propositions of design theory as a utility theory.

In Table 2.3, the guidelines of Design Science describe the aspects that should be considered during the study process. Hevner et al. (2004) point out that March and Smith (1995) identified two design processes and four design results that are constructs, methods, methods and instantiations. According to Hevner et al., the purpose of evaluation is to find out the utility of the artefact, and to show, how it can solve the decision problem. In this study, Hevner et al.'s guidelines are explored to find out, how these guidelines can be utilized, when I am developing an evaluation method for virtual learning application.

Table 2.3 Design Science guidelines of research (Hevner et al. 2004)

Guideline	Description
1G. Design as an Artefact	Design-science research must produce a viable artefact in the form of a construct, a method, a method, or an instantiation.
2G. Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
3G. Design Evaluation	The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.
4G. Research Contribution	Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies.
5G. Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.
6G. Design as a Search Process	The search for an effective artefact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
7G. Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

The first guideline states that design-science research must produce a viable artefact, which can be a construct, a method, a method or an instantiation. By considering 1G, I utilize this guideline, since I am developing an evaluation method for a virtual learning application. The second guideline emphasizes that the objective is to develop technology-based solutions, and a solution has to solve an important and relevant business problem. When I accept that a decision-making problem in an educational organization fulfils this requirement, then a single requirement is fulfilled. The second requirement identifies that an evaluation method is a technology-based solution. The third guideline stresses that an evaluation method must be rigorously demonstrated which I shall carry out. The guideline a research contribution, requires that evaluation results are discussed and possible scientific and practical contributions shown, and that possible limitations and weaknesses are recognized. The guideline: research rigor stresses that developing process of an evaluation method for virtual learning application is carried out by utilizing scientific methods. The guideline: design as a search process, is accepted

in this study, when I develop and demonstrate the evaluation method for virtual learning application. The last guideline will be fulfilled, when I publish results of the evaluation method for a virtual learning application.

Hevner et al. (2004) identified five evaluation methods, which I will explore to clarify what types of evaluation method I am developing, and can it be classified in more than one category. In Table 3.4, the observational evaluation method is classified to be utilized in case studies and field studies. The analytical evaluation methods can be a static analysis of structure of an artefact, and it can be architecture analysis, the purpose of which is to check that the selected virtual learning application fits the used infrastructure of information environment on the object organization. The experimental evaluation method can be used if I can organize an evaluation process in the controlled situation. The evaluation methods can be utilized when I can organize a black box and/or white box tests and the purpose is to check that specified criteria, which are based on a quality requirement design process of software engineering. The last types of evaluation methods are descriptive evaluation methods. These types of evaluation methods can be utilized, when I am exploring available knowledge base, or I am considering the use of virtual learning application in the future, preparing scenarios how virtual learning application usage will continue to develop in the near future.

Table 2.4 Types of evaluation method by Hevner et al. (2004)

1. Observational	Case study: Study artefact in depth in business environment. Field study: Monitor use of artefact in multiple projects.
2. Analytical	Static Analysis: Examine structure of artefact for static qualities (e.g. complexity). Architecture Analysis: Study fit of artefact into technical IS architecture. Optimization: Demonstrate inherent optimal properties of artefact or provide optimality bounds on artefact behaviour. Dynamic Analysis: Study artefact in use for dynamic qualities (e.g. performance).
3. Experimental	Controlled Experiment: Study artefact in controlled environment for qualities (e.g. usability). Simulation: Execute artefact with artificial data.
4. Testing	Functional (Black Box) Testing: Execute artefact interfaces to discover failures and identify defects. Structural (White Box) Testing: Perform coverage testing of some metric (e.g. execution paths) in the artefact implementation,
5. Descriptive	Informed Argument: Use information from the knowledge base (e.g. relevant research) to build a convincing argument for the artefact's utility). Scenarios: Construct detailed scenarios around the artefact to demonstrate its utility.

The second method of a design research process proposed by Verschuren and Hartog (2005) offers six steps or stages, which should have carried out, when I consider, how the development process of an evaluation method should be organized. Verschuren and Hartog (2005, p. 738) defined evaluation: "*to compare separate parts of a designing process with selected touchstones or criteria (in the broadest sense of the word), and to draw a conclusion in the sense of satisfactory or unsatisfactory".* Verschuren and Hartog propose that the final evaluation process consists of three stages. The object of their study was an application-developing process. They tried to adopt the developing process method to the decision process, where the decision makers evaluate application packages. However, when considering the evaluation method for virtual learning application: this method needs revision. Anyhow, Verschuren and Hartog's design research process method offers a base to develop the evaluation method by using similar steps as they proposed for new application (artefact) designing. Verschuren and Hartog defined an ex ante and an ex post evaluation, arguing that the ex ante evaluation means the evaluation of an evaluation process that is carried out before an implementation or use and the ex post evaluation means that an evaluation process can be started after the implementation or after using the artefact for sometime. They emphasize that the term ex post is relative in nature and the evaluation has a formative function during the designing process. By following Verschuren and Hartog's designing process, it is accepted in this study, that an evaluation process of a virtual learning application, belong to the product evaluation, when the evaluation is considered the package of virtual learning application.

In Table 2.5 a design science process method is represented and on the column of an evaluation process, I try to explore, what evaluation activities should be included in each stage, when I consider an evaluation process in more detail. By identifying needed activities of an evaluation process, I try to demonstrate how well Verschuren and Hartog's design science process method can fulfill the requirements of an evaluation process. When I consider how to apply Verschuren and Hartog's design science (research) method to an evaluation process, I recognized that the first three stages include problem-reduction heuristic, and the stages 4 and 5, I am applying a state-transition heuristic. The 6 stage should be named discussion and conclusion, since in this stage I can consider scientific and practical contributions of an evaluation method and possible compare it with other evaluation methods to check that it is equally good or better than the best available evaluation method.

Table 2.5 Design science process method by Verschuren and Hartog

Stage	*Description*	*Activities of evaluation process*
1.First hunch or Initiative	The need to design a new or modified artefact. The aim is to generate a small set of goals for artefacts	A researcher tries to specify evaluation problems, and try to find out what are primary and secondary goals of evaluation process. In this stage, evaluation is carried out to check that the specified problem is relevant and evaluation process can be started.
2. Requirements and Assumptions	Requirements of artefact and assumptions of future use of artefact	A researcher tries to specify, how to explore and define needed requirements and draw tentative assumptions of evaluation method

		and needed evaluation metrics. A researcher tries to identify essential stakeholders and tries to clarify, what are the essential requirements that should be fulfilled. A research tries to evaluate that requirements and assumptions are correctly specified and that evaluation method can be constructed based on the requirements and features of an artefact.
3. Structural specifications	Design Requirements and Assumptions. Structure and characteristics of artefact	A researcher continues to develop an evaluation method that is based on checked requirements and features of a virtual learning application. A researcher evaluates that an evaluation method is based on valid requirements and features of a virtual learning application and that structure of an evaluation method is valid and it can be verified.
4. Prototype	The basic method and first versions of artefact	A researcher tries to demonstrate that developed evaluation method can produce expected results.
5. Implementation	The final release of artefact is implemented	A researcher writes results of evaluation process and draws suggestions and recommendations based on demonstrated results of evaluation process.
6. Evaluation ex post	Checking that short and long-term effect of utilisation and effectiveness are fit and goals are satisfied and met.	A researcher tries to consider what are scientific and practical contributions of the evaluation method(s) and what are constraints, which should be taken into account, when someone repeats this evaluation process by utilizing used evaluation method and metrics.

Rossi and Sein (2003) proposed design research process, which sinclude different stages than Verschuren and Hartog's design research process method. A design research process by Rossi and Sein (2003) includes the following activities:

1. Identify a need (Problem solving),
2. Build (method and instantiate),
3. Evaluate (verify and validate),
4. Learn (Current and Emergent), and
5. Theorize.

What can be said Rossi and Sein's design research process method? I emphasize that if I think a development process, in which the main objective is to develop a new or modified IT artefact, then Rossi and Sein's design research process seems to be applicable. However, when I

consider, how to utilize Rossi and Sein's design research process method to an evaluation process, I can conclude that the first activity identifies a need that can be used for evaluation, since before starting an evaluation process I have to explore and identify at least an evaluation problem. The second activity: build a method and instantiate, may be applied, when I try to specify an evaluation method or evaluation methods. The third activity: evaluate (verify and validate) points to software testing processes, where verification and validation are used. The fourth activity: learn is usable, since I have to clarify and report, what lesson will be the learnt in this evaluation process and how the results of an evaluation process can be utilized in the future and in the decision-making process. The fifth activity: theorize means that I have to try to draw some conclusions depending on what the results of an evaluation process can add to the knowledge base and are there any scientific contributions.

By comparing the Verschuren and Hartog's design research process method to Rossi and Sein's method, it can be observed that First hunch (Initiative) and Identify both include problem solving, but Rossi and Sein's method is included in Stage 2 and 3 of Verschuren and Hartog's method. In comparison to prototype and implementation with build stage in the Rossi and Sein's method, I can recognize similar activities.Stage 3 in the Rossi and Sein's points out evaluation after build, while Verschuren and Hartog propose evaluation as an ex-post process. In the Rossi and Sein's method, Stage 4 and Stage 5 are different in comparison with the Verschuren and Hartog's method. However, I can say that Rossi and Sein's method include problem-reduction (solving) heuristic, but not state-transition heuristic. Stage 6 ex-post evaluation in the Verschuren and Hartog's method includes a summative evaluation method of the selected artefacts, and the purpose is to address two questions; how well has the existing problem been solved, and has the goal of the evaluation process been achieved.

During the research project, I recognized that commercial off-the-shelf evaluation methods have been developed since 1990s, when I continued to explore the off-the-shelf evaluation methods, I identified that the second period has been started at the beginning of 2000. One of the commercials off-the-shelf software evaluation methods that I will shortly explore is Kontio's (1995a, b, 1996) off-the-shelf software package option (OTSO), since it is one of the first evaluation methods as far as I know. Kontio's OTSO method is developed assuming that software requirement specification, design specification, project plan and organizational characteristics are available, so an evaluator or group of evaluators can concentrate on an evaluation process, which includes the following sub-processes:

a) define evaluation criteria,
b) search,
c) screening,
d) evaluation and
e) analysis of results.

Kontio's OTSO-method includes two other activities, which are deployment and assessment. I considered that these activities are utilized after an evaluation process.

The first activity of Kontio's evaluation method is defining evaluation criteria, which implicitly emphasizes that an evaluation problem already exists and an evaluator or evaluators can start to specify evaluation criteria, which can be based on the features of an application

(software package). The second activity: search means that evaluators try to find out possible software packages, which can be used to solve a problem. The screening activity includes that evaluators can select a set of alternatives (more than a single application), which will be evaluated by utilizing developed evaluation criteria. The last activity means that evaluators write a report of achieved evaluation results, and evaluators are preparing suggestions and recommendations for decision-making.

I identified four methods of the design research process and tried to identify how I can create a development process of an evaluation method for virtual learning application based on methodology. To conclude with methodological consideration, I will compare explored design research process methods to the selected method (method) in Table 2.6. In this research, the methodological background was based on Vaishnavi and Kuecher's general design research method, which I modified and called it the structure of evaluation process method.

In Table 2.6, activities of design research processes are arranged according to the structure of evaluation process method. The purpose is to explore, how other methods' activities fit to the activities of structure of evaluation process method.

Verschuren and Hartog's Stage 2 included definitions of requirements and assumptions, which I will utilize when I am exploring stakeholders' requirements, properties of learning method, and features of a virtual learning application. The activity of the design research method by Rossi and Sein proposes to build evaluation criteria. Kontio's OTSO-method proposes to define evaluation criteria. Verschuren and Hartog's method included activities in which a designer or an evaluator specifies the structure of evaluation method and builds a tentative prototype. Kontio's OTSO-method activity includes search processes, in which a designer or an evaluator tries to find available options (alternatives). The structure of the evaluation process method includes activities, in which are developed evaluation methods. In this study developed evaluation methods will be based on requirements of stakeholders, properties of learning method and features of a virtual learning application.

Verschuren and Hartog's method included an ex-ante evaluation activity, in which the achieved results will be analyzed and possible practical and scientific results are recommended to report both practitioners' point of view, and it is suggested to explore how useful the achieved results are from the scientific point of view. Rossi and Sein's method included two activities, the first is learning and the second is theorizing. The first activity: learning guides a developer or an evaluator to check what is learnt, and how this learning can be utilized in the future. The second activity: theorize includes a guide that a developer or an evaluator should be considered what kinds of theoretical results and possible contribution the research project includes. The concluding activity of the structure of the evaluation process method is split into discussions and conclusion, in which possible results of an evaluation process are discussed and in conclusions both scientific and practical points of view are drawn.

Table 2.6 Summary of design research processes

The structure of an evaluation research process	**Design science process method (Verschuren and Hartog, 2005)**	**Design research process method (Rossi and Sein, 2003)**	**OTSO (Kontio, 1995a,b,1996)**
The identification of development problem and research method	First hunch or initiative	Identify a need	Requirement specification, Design specification, project plan and organizational characteristics
Defining the evaluation criteria	Requirements and assumptions	Build	Define evaluation criteria
Developing the evaluation method	Structural specifications and prototype	Build	Search
Demonstrating the evaluation method	Implementation	Evaluate	Screening and Evaluation
Results	Evaluation	Learn and theorize	Analysis of results

To consider, what kinds of reasons and problems have been revealed evaluation processes, I identified Willcocks and Lester's (1997) findings that an evaluation process could be classified into three categories:

1. The IT artefact investment has to be carried out for a competitive reason, but clear financial justification and evaluation practice cannot provide data and information for making an investment decision.
2. IT artefact investment has to carry out for IS infrastructure reasons, but it is difficult to separate clear impact of investment and outcomes.
3. The senior management's lack of understanding about suitable IT artefacts, and how the organization is using information systems and information technology in their daily processes, and how they are managing these processes.

These categories above are quite general, but give some ideas that evaluation methodology and methods are difficult practitioners to use.

Grimslay et al.'s (2006) e-government application research has been explored stakeholders' satisfaction and trust. When I identify and explore requirements of stakeholders, I should recognize that the satisfaction and trust effect, how different members of groups of stakeholder are willing to use, for example, a virtual learning application. Many evaluation researchers have identified difficulties and problems that are revealed during the evaluation process, e.g. Van Grembergen (2001). Typical identified problems are classified by the following categories:

a) Budgeting practices of organization
b) Financially oriented evaluation techniques
c) Cost overstating and delivering timing

d) Working with new technologies and higher level of risks
e) Sufficient effort of evaluation time
f) Lack of IT/IS planning and missing strategic climate.

These problem areas reveal why it is difficult to find out a single evaluation methodology and method. I argue that many unjustifiable dimensions in evaluation method exist that are measured only qualitatively. When senior management is searching for a broader view and a better evaluation method, the project management may consider that the cost of creating a good evaluation method cannot be developed with a given time period and because of this, they do not start creating any one.

2.4 Socio-technical approach in evaluation study

In this section I consider, how an organizational change and information system's project should be planned as an aligned process, and how a socio-technical approach can be utilized as a meta-method of evaluation. Markus (2004) presented the term technochange to describe a technology-driven organizational change situation. Harison and Boonstra (2009) suggested that essential dimension for technochange process are knowledge and skills that are needed for information system managers and business managers. Knowledge and skills are specified to eight dimensions. Knowledge and skills are also essential for the evaluator. By following Iivari's (1991) classification, I consider how Mumford's (1983a) ETHICS-method is a plausible approach to develop a meta-method in an evaluation process. The meta-method means higher order method, which can be used to as a tool to analyse research method. According to dictionary the meta means a position behind or beyond.

2.4.1 Socio-technical features in information system's project

A socio-technical approach in an evaluation research is interesting, since it integrates information systems or information application and its potential users as a holistic multi-dimension system. Markus (2004) considered how information systems could affect organizational processes and called this a technochange. The term technochange is according to Markus (2004) technology-driven organizational change. Furthermore, Harison and Boonstra (2009) agree with Markus by continuing "... capturing the broad spectrum of aspects that are related to and have an impact on changes within organizations." Markus identified how information system project and organizational change programs should be integrated and planned aligned in a way that it is possible to set outcomes and solutions, in which I can take into account both the information system projects main objectives and the objectives of the organizational change program. Markus (2004) called that as a technochange situation. During an information system project and organizational change program, needs for different types of specialists exist. The role of organization's managers is to approve, provide funding for the project and accept requirement specification for the information system. The role of information system's specialists is to perform project management and to coordinate activities with business

managers and with possible vendors' consultants. The role of evaluators is included in other specialists in Markus' typology.

Harison and Boonstra (2009) identified the following list of aspects that are identified in technochange project management:

1) Assessment of competencies of professionals in the organization and their appropriability to lead technochanges in organizations,
2) Allocation of managers to technochange projects on the basis of their managerial, organizational and personal competencies,
3) Matching the technical and managerial staff with projects (either as technochange managers or as participants in various stages of the project) on the basis of their personal and managerial skills,
4) Provision of individual or group training as part of the training programme for technochange managers, managers in the organizations undergoing the technochanges, and consultants

Harison and Boonstra presented the following taxonomy of competencies related to technochange projects:

Knowledge	*Information system and organizational change*
	Technochange and risk and success factors
Skills	*Communication, project management and leadership*
	Consequences of change

Harison and Boonstra (2009, p. 289) specified the dimensions which are described in Table 2.7.

Table 2.7 Assessment model for technochange project management

Information technology and information systems knowhow	Actual knowledge of the IS/IT field (at a level of higher education) and experience in IS/IT projects in leading and responsible positions.
Organizational change	Knowledge of the fields of organizational change and organizational development (at a level of higher education). Experience in organizational change and organizational development projects, including managing, leading and operative issues. The ability to understand organizations and their work processes in their specific contexts.
Technochange	Knowledge of IT-related organizational change processes. Clear insights into the implications of such changes for organizations. Experience in technochange projects in terms of managing, leading and fulfilling operative functions
Risks and success factors of technochanges	Insights into risks and success factors that closely affect the technochange processes. Experience in dealing with these factors in technochange projects.
Communication	Skills and experience in verbal and intermediary communication, such as conducting interviews, writing reports, presentations, listening, motivating and convincing.
Process management	Skills and experience in planning, managing and evaluating IT-related organizational changes.
Leadership	Experience in directing and leading IT-projects and

	organizational change. The ability to provide instruction, facilitate and advise management and project employees. Personal skills are empathy, diplomacy and an understanding of organizational politics.
Consequences of change	The ability to recognize and anticipate the results of the technochange programmes and their impact on organizations, their performance and work processes.

Harison and Boonstra (2009) concluded that "Technochange projects, and in particular IT-related organizational changes, should be managed with a deliberate focus on a broad variety of dimensions related to inter-personal and organizational communication skills, project management and change management, *inter alia*. Technochange-managers who possess these essential competencies can significantly influence the success of their projects. "

When I think about how an implementation process for virtual learning application may affect organizational processes and activities, I can point out that after installing a new virtual learning application doubtless it changes learning processes and learning activities. This situation should also be recognized during an ex-ante evaluation process.

2.4.2 Information System's approaches and meta-method

Iivari (1991) has classified Information Systems' schools by using textbooks as a source, and he presents the seven school of Information Systems' development in his article. These schools are:

1) Software Engineering (SE),
2) Database Management (DM),
3) Management Information Systems (MIS),
4) Decision Support Systems (DSS),
5) Implementation research (Ir),
6) Socio-technical approach (Sa), and
7) Infological approach (Ia).

Iivari et al. (1998) presented five other IS development approaches and methodologies and define the following contrasting approaches;

1) the inter-actionist,
2) the speech act-based,
3) the soft systems methodology,
4) the trade unionist, and
5) the professional work practice approaches.

The concept of methodology as "an organized collection of concepts, methods, beliefs, values and normative principles supported by material resources" defined by Iivari et al. (1998, p. 165). The information system development approach (ISDA) is defined as "a set of goals, guiding principles, fundamental concepts, and principles for the ISD process that drive

interpretations and actions in ISD" (p.166). Iivari (2007) continues his paradigmatic analysis and presents the Information System's paradigms as a part of design science. The concept paradigm is a pattern or model.

Rose (2000, p. 25) considers methodologies and points out that "each of the alternative's approaches addresses perceived deficiencies of the orthodoxy. In the case of 'no method', the perceived weakness is analysis overkill, in the case of prototyping it is the lack of participation and incomprehensible paper specifications, in the case of rapid application development (RAD), it is the length of development time. ETHICS addresses (from a socio-technical viewpoint) the perceived weakness in structured methods of lack of participation, the inter-actionist approach addresses the lack of sensitivity to social and political context, and speech act therapy tries to rectify simplistic denotation use of language. Soft systems methodology (SSM) takes on objectivist assumptions and over-simplified problem formulations, the trade union approach addresses the power imbalances and goal differences, and the work practice approach (PWP) tries to examine the software development process as it is, rather than as the orthodoxy prescriptively implies it ought to be."

By following Iivari's typology and trying to apply and select a meta-method for this study, I argue that the socio-technical approach seems to be applicable to utilize as a framework. The socio-technical approach means that the stakeholders are participating in the evaluation process and evaluate technical and social aspects of the virtual learning applications. Mumford (1983a,b, 2007) developed the Effective Technical and Human Implementation of Computer-based Systems (ETHICS) -method in 1983. Next, I will to try to demonstrate, how the ETHICH method can be utilized when I describe how to create a new evaluation meta-method for a virtual learning application. The usage of ETHICS method is interesting, since it includes socio-technical approach, and it describes how stakeholders' roles should be taken into account.

2.4.3 The Ethics-method as a meta-method in evaluation

The developed evaluation meta-method for virtual learning application is developed by utilization of the ETHICS-method, and it is described in Table 2.6. The main purpose for developing an evaluation meta-method for virtual learning application is to demonstrate that it is possible to utilize the ETHICS-method and in this way include the socio-technical approach to evaluation. As far as I know, the only research in which ETHICS-method is applied is Kunda's (2001) evaluation research.

Task 1 describes the objective setting process, in which stakeholders create and define the objective of the evaluation process that should be achieved and accepted so that the evaluation process is successful and the valuable information is produced for decision makers. Task 2 includes an adaptation process and during the adaptation process, the stakeholders negotiate what kind of organizational structure and organizational changes they need. In addition, they discuss the technological requirements and constraints that may or may not support the selection of a virtual learning application. Task 3 is an evaluation process that includes an ex-ante evaluation process. In task 3, the evaluator or evaluators analyze and evaluate alternatives of virtual learning applications by using an ex-ante evaluation method. Task 4 will be carried out

after the implementation of the virtual learning application or applications, if more than one application is selected. The logical reason and proposals will demand that the organization should carry out an ex-post evaluation when the removing decision is done. The ex-post evaluation will produce the results that can be called a lesson learned.

Table 2.6 The evaluation meta-method for virtual learning application.

Evaluation	Tasks	Description	Stakeholders
Objective of evaluation process are defined, and need for evaluation is accepted.	1.Objective setting	Vision and mission of organization are defined and accepted. Changes of learning methodology and needed teaching tools are recognized. Learning styles of students are studied.	Headmaster Directors Managers CIO IT-designers Teachers Students
Criteria of evaluation method and evaluation criteria are defined and accepted.	2.Adaptation	Organizational structure and needed changes and changes of teaching strategies are discussed. Negotiated results are compromises, not optimal results are accepted. Technological requirements and constraints are recognized.	Headmaster Directors Managers CIO IT-designers Teachers Students
Evaluation process is 1. Ex-ante evaluation	3. Integration - Technology - People - Task Organizational environment	Integration means that technology, people, task and organizational environment are integrated to new learning and teaching methods. Technology is evaluated using requirements and constraints as a source for evaluation criteria.	Headmaster Directors Managers CIO IT-designers Teachers Students
Evaluation process is 2. Ongoing evaluation	4. Stabilization	Stabilization state means that implemented virtual learning application or applications are used and these are maintained. During this state, a new requirements and needs will arouse. A new evaluation process is started.	Headmaster Directors Managers CIO IT-designers Teachers Students
Evaluation process is 3. Ex-post evaluation	5. Demolition	Virtual learning application is de-installed and usage is stopped. A new virtual learning application is installed. In reality, it should run both old and new application parallel for some time that it will checked that a new application satisfies requirements and objectives.	Headmaster Directors Managers CIO

I point out that by utilizing the ETHICS-method in Table 2.6, I took the task of Mumford's ETHICS-method and adapted it to our evaluation process, and the main objective for this is to demonstrate that an evaluation process is possible to identify by using ETHICS-method. Stakeholders' roles are essential in an evaluation process. The ETHICS-method can be utilized as an evaluation meta-method for an evaluation process.

The original ETHICS-method does not include a demolition task and the demolition task 5 is added to the method by the reason of the study, because the demolition task closes the evaluation process. The adaptation of the ETHICS-method to the evaluation process connects stakeholder theory and the information systems' developing method to the evaluation research approach and organizes an evaluation of the organizational vision and mission.

When starting to use a new application, it may demand that the data must be converted to new representation format. The ex-post evaluation criteria should include transition work and costs, and quitting work and costs, so that decision makers are aware of the total cost of the old application and are capable of evaluating the new application and developing the requirements and properties from the updated data and information. Mumford defines that participation can take place at three levels of an organization: a*) strategic, b) tactical, and c) operative level.*

According to Mumford, job satisfaction is the reason for the participatory design (PD), which enables that technical and social aspects are brought to the developing process. This ensures that the acquired or developed application can be used in a suitable organizational structure in the future. The one crucial assumption that Mumford has made (implicitly) is that employees and employers (managers) share common objectives, when they solve IT problems in the organization. However, critical researchers point out that this assumption is not necessary valid, in reality. The main objective of the ETHICS-method is to 'fit' technical and social aspects to IT artefact developing process. I agree that learning style is personal and it is difficult to change. However, it is important factor to taken into account, when I try to define evaluation objectives. The learning styles should be noticed, when facilitators and teachers are preparing course materials and instructions. This point of view is based on my teaching experiences.

Mumford defines four important objectives for designing, and these are the following list:

"1) to base systems design on an accurate and careful diagnosis of business problems and human relations needs,

2) To give equal weight to these problems and needs,

3) To ensure that the design task encompasses good organizational design as well as good technical design,

4) To create systems which are effective, efficient, acceptable and stimulating."

Mumford recognizes two groups that are important when developing artefacts. The groups are the steering committee and the design or design groups, if the developing is handed to more than one working group. She defines participative roles according to membership of the steering committee or design group. By following steps in Mumford's ETHICS-method, the last step is the evaluation. She recommends variance analysis and job satisfaction analysis as evaluation tools. The aim of variance analysis is to find out a work- systems problems and difficulties, not to use statistical variance analysis.

2.5 Summary

To conclude, how ETHICS method can be used as an evaluation meta-method, I demonstrated it to this research phenomenon. By applying ETHICS-method to the evaluation as a meta-method, I try to show stakeholders' roles in this research context.

The conclusion of two science approaches, I propose that this research process can be presented by using the following components in Figure 2.7. The first component design science (research) evaluation process method creates a framework for this study. The second component educational approach offers features of evaluation method.

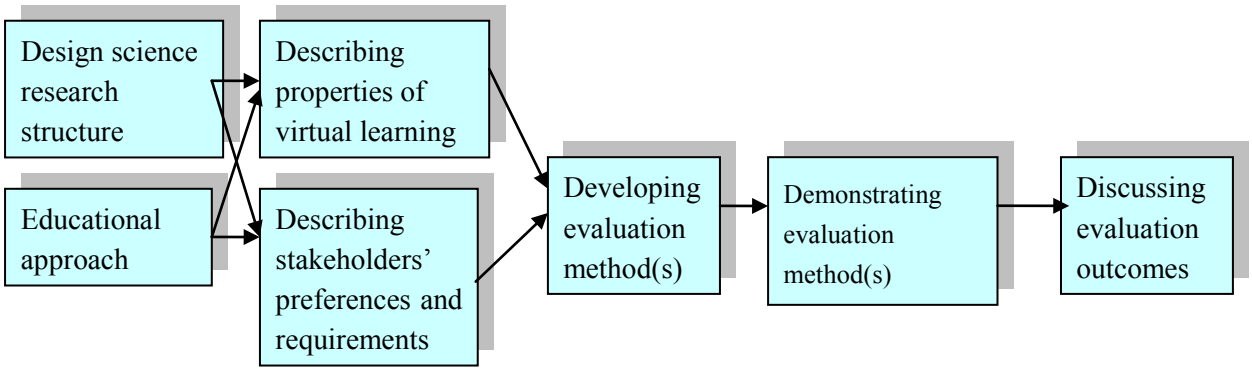

Figure 2.7 The structure of development process of an evaluation method for virtual learning application

Chapter three

3 Virtual learning environment and learning

3.1 Introduction

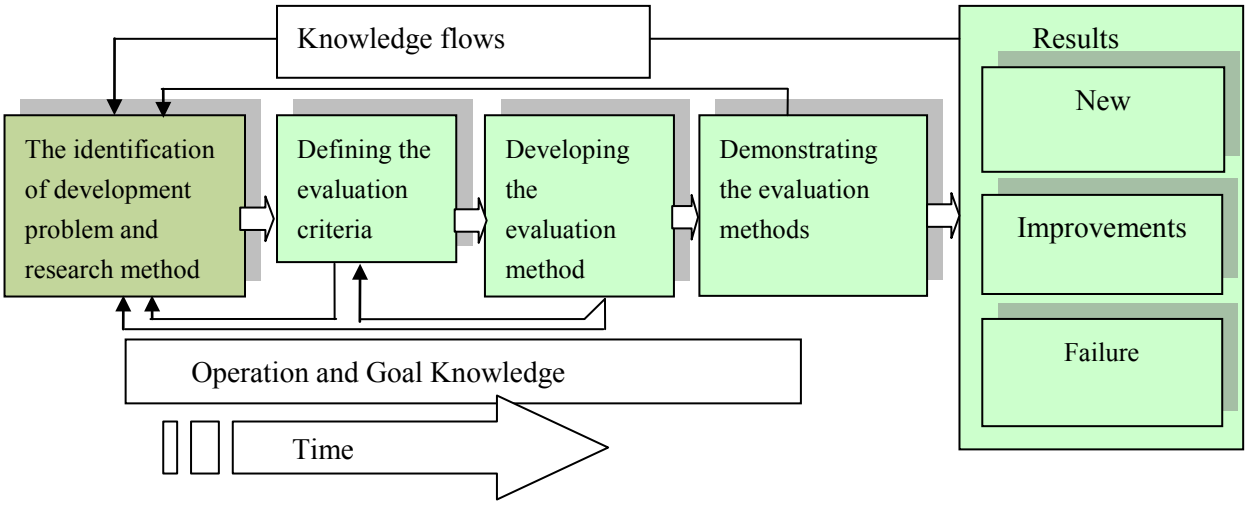

Figure 3.1 The structure of an evaluation research process for a virtual learning application

In Section 3.2, I will try to identify how learning is studied and how different learning methods and styles should be taken into account when developing an evaluation method. It is true that different learning models and learning styles may vary, in reality. However, I believe that when constructing evaluation objects and evaluation criteria it is necessary to take into account some features of the learning method.

In Section 3.3, I will explore how a virtual learning environment is constructed and how a virtual learning application can be identified as a research object in this study. The educational concepts and terms that are used to create an evaluation method for a virtual learning application are analyzed, and the evaluation method is linked to the specified learning method. A virtual learning environment and its components are based on Li's (1997) and Khalifa's (2001) work. A virtual learning environment can be represented in the three dimensional figure, in which place, time and learning methods are described.

Kolb's experiential learning cycle is presented to show how the learning process can happen and how different learning styles can be recognized at the individual level. In their SOLO taxonomy, Biggs and Collis (1982) described how quantitative and qualitative knowledge may affect the learning processes and what kinds of outcomes can be achieved. The objectivist, collaborative and constructivist learning models are represented by using Li's (1997), Leidner and Jarvenpaa's (1995), and Cheetham and Chivers's (2001) research.

A collaborative problem based learning is analyzed in more detail. Therefore, I construct part of evaluation criteria for a virtual learning application based on the collaborative problem based learning. The collaborative problem based learning is selected for two reasons. Firstly, the problem based learning is used in the case unit. Secondly, its features can be applied to the features of an ideal virtual learning application. The term ideal virtual learning application is presented. Therefore, the requirements of the ex-ante evaluation method for a virtual learning application may include features that are suggested, but may not be available. Learning at the society level is described by using Maes et al.'s (1999) model of life-long learning by sharing.

3.2 The concepts and terms in a virtual learning environment

In this section, I explore how the learning environment and different types of learning are identified, and how I am able to specify the specified learning environment and virtual learning application that are used in this study to the basis of evaluation object and evaluation criteria. I argue that the virtual learning environment is an upper concept, and it should be split to sub-concepts that are more identifiable and then more realistic objects as a research object.

3.2.1 The definition of virtual learning environment

According to Khalifa (2001), t*he learning environment (LE)* can be defined as having three dimensions: a time, a place and learning method. Khalifa used Norman's (1997) two-dimensional environment as a basis, when he presented the three dimensional learning environment. Khalifa applied Leidner and Jarvenpaa's (1995) and Li's (1997) proposals, when he added learning models to his environment. The learning models are the objectivist, collaborative and constructivist.

Khalifa and Lam (2002) studied effects on web-based learning by demonstrating differences between distributed passive learning and distributed interactive learning. The outcomes of the two different web-based learning environments were measured by using the quizzes (N = 5) that were based on the structure of the observed learning outcome (SOLO). Khalifa and Lam provided the two web sites and offered these to both student groups. Both web sites included the same management information system course, but learning materials were differently presented. The distributed passive learning web pages were provided as a single text file and a single presentation file link. Learners could open the learning material and read it, but without navigating. The distributed interactive learning (DIL) web pages were provided by hypertext navigation links to the learning materials. The hypertext links were based on a concept map, which was designed by the course instructor. The student groups were randomly divided into two groups (N = 32). Khalifa and Lam (2002, p. 355) concluded "... the authors only considered the basic form of the DIL environment, which supported constructivist learning but not collaborative learning (no groupware capabilities)."

Li (1997, pp. 322 - 323) proposed that the learning and the usage of information technology (computer –based learning tools) is arranged in the following way. The teacher transfers

knowledge to students via the Internet in an objectivist learning model, while collaborative and constructivist learning models ICT tools are used to organize, arrange and transfer knowledge from a learner to learners and from a learner to a teacher. Li argued that collaborative learning method and information technology tools offer a way that students can develop their knowledge through shared information. The constructivist learning model and information technology allow students to construct knowledge from shared knowledge in a dynamic structure.

In Figure 3.2, I present three dimensional learning environments. Khalifa does not use the concept virtual learning environment. However, I assume that the distributed passive and interactive learning environment can be named as virtual learning.

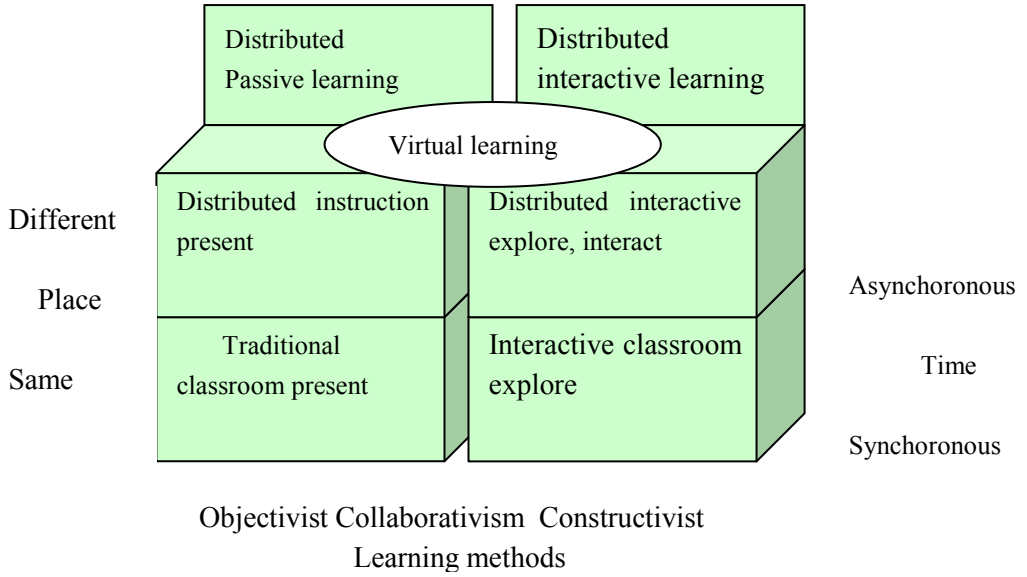

Figure 3.2 A three dimensional learning environment (modified from Khalifa, 2001).

To summarize the discussion of the learning environment, I first borrow Piccoli et al.'s (2001) definition of *the virtual learning environment "*... a computer based environment that has relatively open systems, allowing interactions and encounters with other participants". The second definition *the virtual learning environment* is a learning management system. It synthesizes the functionality of computer-mediated communications software (e-mail, bulletin boards, newsgroups, etc.) and on-line methods of delivering course materials (e.g. the WWW)." (Britain and Liber, 1999). And the third " ... I (Koponen) found that the e-learning environment is appropriate to be organized so that there are both formal and informal learning supporting features, i.e. various learning materials for various learning styles, which can be used by following various logically proceeding learning paths or without any sequential order." (Koponen, 2008). I point out that even Koponen seems to prefer the e-learning environment, while I use in this research the concept *virtual learning environment*. It is the fact that other researchers also use the concept online learning environment. The concept online learning environment includes the assumption that the learning environment is provided by wired local and global connection. However, learners can use mobile devices to get a connection to a

learning environment via radio network or wireless network, so I prefer the concept virtual learning environment.

Next, I try to describe how the virtual learning environment can be described by using its components. By identifying its components, I try to show that the evaluation method for the virtual learning environment has to be constructed by identifying a different evaluation method for each component. In Figure 3.3, I illustrate the virtual learning environment by showing its components. These components are the following: virtual learning application, learning management system, content producing applications, content management system and virtual learning platforms. The virtual learning environments, e.g., Moodle, Discendum Optima, Backboard, Future Learning Environment typically includes more than one application.

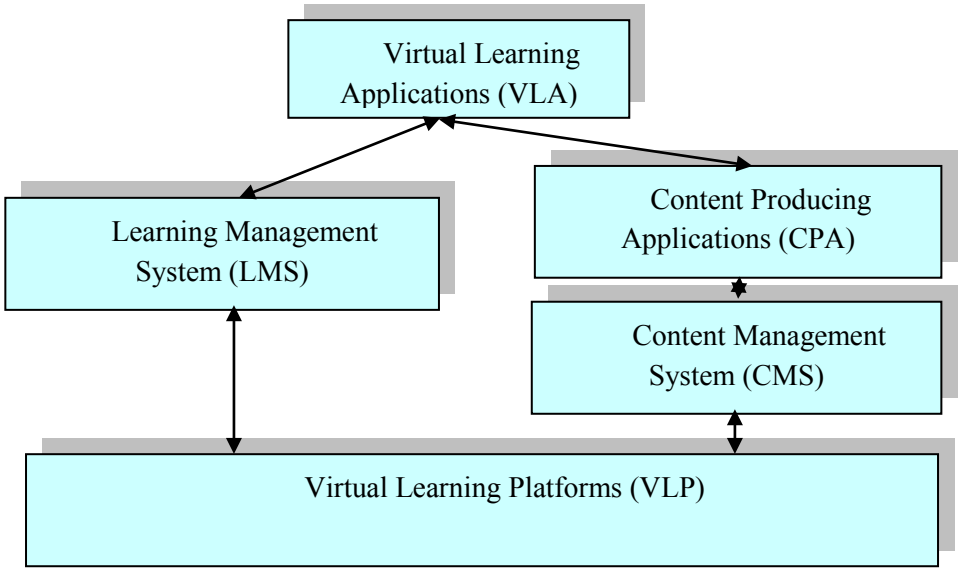

Figure 3.3 The virtual learning environment and its components.

3.2.2 The components of virtual learning environment

A virtual learning application (VLA) is a component of a learning environment. This definition emphasizes that the virtual learning applications are planned to use via client application or via Internet browser. The virtual learning application demands that all learning materials are in the digital format. This definition emphasizes that the learning material can consist of text, image, video, drawing and audio (speech). It is a fact that the virtual learning application can be used via local and/or global network. The first generation of virtual learning applications used their own client application, but after the Internet was launched, the main purpose has been to use an Internet browser as a client application. This option minimized the need for a client application. By applying an Internet browser as a common user interface, I can assume that all learners have been familiar with it.

The Content Producing Application (CPA) concept means that facilitators, tutors, teachers, and students can use the tools to produce curriculum descriptions, course materials, assignments, assessments, quizzes and other forms of materials used during course teaching and learning periods. Examples of CPAs are word processing applications, image creating, and editing applications, presentation-producing applications. The virtual learning application is used via local and global network, and the client application is an Internet browser and very seldom a special client application.

The Learning Management System (LMS) and components mean that student, teachers and others can use the virtual learning application (VLA) login only once (Single sign on-method) if possible. This is where exist the Directory applications that are based on the Lightweight Directory Access Protocol (LDAP) (e.g., eDir (NDS) by Novell and Active Directory by Microsoft) are situated. Some VLAs use technology that allows users (students and teachers) to create their own username and password. In this way, the users can register themselves and start to use the virtual learning application after registration.

The Content Management System concept refers to, that the produced curriculum and course materials can be handled (saved, restored, and produced) that learners, tutors, teachers, and facilitators can access the required learning materials, when they need it. The curriculum and the course material production needs advanced producing tools that are easy to implement and use by facilitators and teachers. The course material consists of text, voice, images, and video clips and all components can be named as learning material. This means that some of these items, such as texts, voices, and images are quite easy to produce, but usable and sophisticated video clip production needs advanced tools and specialized skills. (Here the term facilitator is used as a synonym for a teacher, since the term facilitator is used in the problem based learning method literature.)

The Virtual learning Platform (VLP) is identified as consisting of hardware, operating systems, administrative applications and the network, which can be a local area net, which can include a wireless network. Platforms such as Windows operating system, Linux, UNIX or a mainframe operating system can be used. The assumption is that a virtual learning application can be installed Windows or Linux server. The other concept that is used is the network-learning environment (NLE). In this study, the concept of the network-learning environment is used as a synonym of the virtual learning environment.

To conclude discussion of learning environment and its components, I use in this study the following definitions:

> The definition of a virtual learning environment *includes hardware such as servers, workstations, network devices, printing and scanning devices, and networks. It includes software such as operating systems, database systems, and it utilizes Internet services and browsers. A virtual learning environment consists of learning application, learning management system, content producing applications, content management system, and virtual learning platform.*

The definition of a virtual learning application *is used for sending, receiving and transmitting learning instructions and learning material between tutor and students, where students can share their own digital material by using a virtual learning application.*

A learner can utilize virtual learning application for transferring, creating and building knowledge. A teacher can transfer knowledge, create and build knowledge and interact with learners. A group of learners can share, create, and build knowledge by utilizing virtual learning applications and other components of virtual learning environment.

3.2.3 Other concepts of learning environments

In this sub-section I review other concepts that were used during 1990s, when researchers and educators described it as educational technology. The purpose of this review is to provide some historical background of the research area. In 1990s, in education different concepts were used to describe the virtual learning environment.

According to Bannon and Schmidt (1989) Greif (1988) and Cashman first presented 1984 at the workshop the concept computer-supported cooperative work (CSCW), and Findlay (1989) used CSCW as a base concept in his research too, but defined the collaborative learning work (CLW) concept, so the term Computer Supported Learning Work is used in Education. Bannon and Schmidt commended that the concept "collaborative work" was used in the first half of 19th century in social sciences, so the concept is not so new. Bannon and Schmidt identified the four characters that are typical in the communities, in which computers are used to support work tasks. The four features are the following: the cooperative work, articulating cooperative work, sharing an information space and adapting the technology to the organization and vice versa. According to Bannon and Schmidt, these features are essential core components of the computer-supported cooperative work.

The concept of *the computer-supported collaborative learning* (CSCL) is, according to Lipponen (2002, p. 1), defined "how collaborative learning supported by technology can enhance to peer interaction and work in groups, and how collaboration and technology facilitate sharing and distributing of knowledge and expertise among community members." The first term that needs to be analyzed is collaboration, since the 'computer-supported' is self-evident. The researchers in the education technology area emphasize collaboration as an important and special form of interaction. Lipponen (2002, p. 1) argue that the computer supported collaborative learning (CSCL) is first recognized and was defined by Koschmann in 1996 as an emerging paradigm of education technology. Lipponen argues that CSCL is a sibling of the computer supported cooperative work (CSCW). Lipponen defines the concept of collaboration as "a process of participating in knowledge communities". The term collaboration is defined as a special form of interaction according to Lipponen (2002) and Engeström (1992) who defined three levels of collaboration a) coordination b) cooperation and c) reflective communication. Kligyte and Leinonen (2001, p. 4) define collaboration as interactivities "which enhance collaborative interaction in peer groups and facilitate sharing and distributing of knowledge and expertise among community members." They make distinctions of the two types of CSCL systems:

"1. Online course management and learning material publishing and delivery systems with a collaboration tools.
2. The groupware applications supporting knowledge building in study groups."

According to Kligyte and Leinonen, online course management is a tool for managing online courses and this tool is used by facilitators and teachers and from time-to-time by ICT staff, when they need to organize or backup the learning material. These tools are specialized for the learners use and the main idea of these types of systems is that the learners can use these for a collaborative knowledge building when working in groups. The term learning can be defined as a process of knowledge transfer between sender and receiver. If we agree the definition of learning as expressed then the learning is a mechanical process, which it is not, in reality.

Lipponen (2002, p. 3) points out that two underlining theories exist, namely Piagetian socio-cognitive conflict and Vygotsky's idea. According to these theories, learning is defined as "people gaining knowledge and practicing some new competencies as a consequence of internalization in collaborative learning." or that "learning is more as a matter of participation in a social process of knowledge construction than an individual endeavour." The computers in the collaborative learning process are seen from the four perspectives, according to Crook (1994) these perspectives are:

a) Interaction at the computers,
b) Interaction around the computers,
c) Interactions related to computer applications and
d) Interaction through the computers

The learning process through computers is based on written text, video, image and simulation. The process differs from the face-to-face learning process in that learning can happen at a different time, at a different place and in a different space. Comparing the concept of collaboration defined by Lipponen and the concept of collaboration defined by Kligyte and Leinonen, I can emphasize that Lipponen's definition is a general concept including all processes of participation in knowledge communities. The definition of collaboration by Kligyte and Leinonen is more specific, since it includes peer groups and the sharing and distributing of knowledge and expertise, and implicitly includes the concept of a medium that is used to transfer knowledge among community members, and to a certain extent, it means that expertise is shared between community members. I agree with Lipponen's conclusions that the concept of computer supported learning work (CSLW) is an interesting research area, and there is still an established theoretical framework missing. The study objects and methodologies vary between the studies. The situation is complicated from an Information Systems researchers' point of view, since it is difficult to apply a suitable concept and theory concerning the computer supported learning work as a research area. However, the concept of CSLW and the theory of CSLW are used in a general meaning in this study.

The Communal Web-based Learning (CWBL) is "communal learning as a philosophy of interaction and as a collaborative process of inquiry and problem-based learning." Vahtivuori and Masalin (2000, p. 61). Their arguments are based on Duffy and Jonassen (1992) work. The

virtual learning environments and applications should be developed focusing on students and teachers roles as a learner, and on the social aspects of learning and to understand time and space in the learning processes. Goldsworthy (1999) proposes that ICT technology can be classified into five categories that are

a) from technology,
b) with technology,
c) around technology,
d) through the technology and
e) technlolgy supported management and assessment.

In Figure 3.4, Vahtivuori and Masalin presented the connection of learning and technology by using Goldsworthy's idea. It is important to recognize the overlapping classification. This seems to implicate that learners can utilize technology different way during the learning processes. They use the term "lenses" as a synonym of category. The fifth category is not included in Figure 3.4 is "technology-supported assessment and guidance" which include, for example, grade books, calendars and other tools that can be used by other categories and used to manage learning technology. The model is complex and shows that ICT and learning is a complex research area.

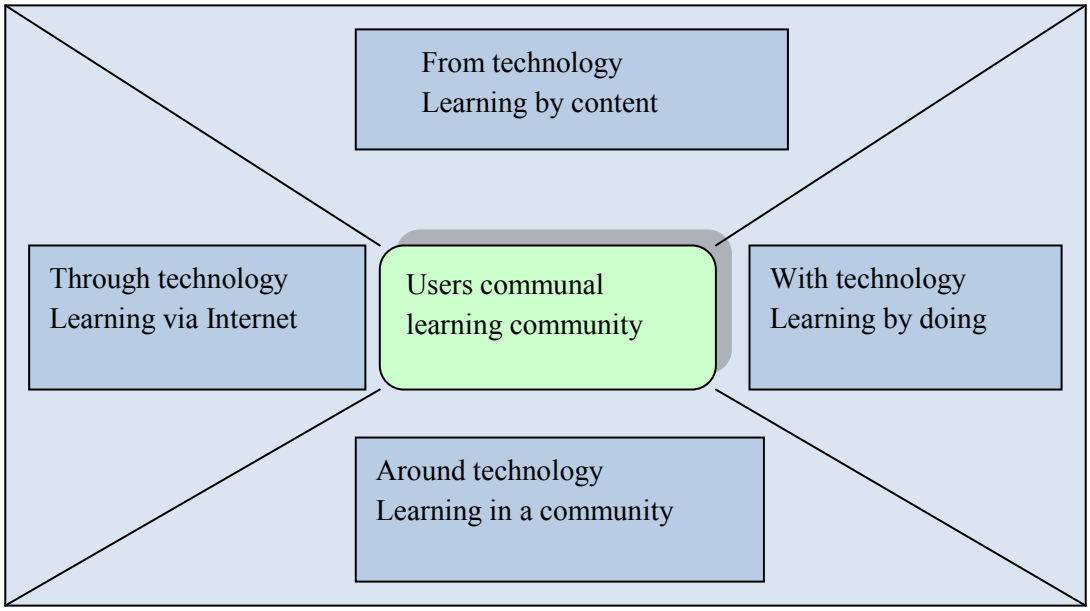

Figure 3.4 The categories of technology and learning processes (modified from Vahtivuori and Masalin).

The purpose of presenting the model in this study is to show that a virtual learning environment, IT artefacts can be used in different learning situations, and the learning processes can provide a base of the preference criteria of the virtual learning application. Vahtivuori and Masalin point out that they use Duffy and Jonassen's idea of learner-centred learning and problem based learning method to develop the web-based learning application. They describe learning as the continuum where individual activity is on the left point, and the communal activity is on the right point.

By comparing Crook's (1994) perspectives of using computer with Vahtivuori & Masalin's perspectives, I point out that Crook's concepts can be equalizing the following way:

a) Interaction at the computers = = learning by content,
b) Interaction around the computers = = learning in a community,
c) Interactions related to computer applications = = learning by doing
d) Interaction through the computers = = learning via the Internet.

The concept of the collaborative learning by interacting with computer and the concept of learning by using a virtual learning environment, identify the same phenomenon, while researchers use different words. In this study, I use the term virtual learning. The categories of technology and learning processes can be explored by including a virtual learning application to this context.

A conclusion of the concepts that are used to describe and identify the learning environment, I assume that computer supported learning, online learning, computer supported collaborative learning, communal web-based learning, and e-learning to describe similar learning environments. However, I prefer to use the term virtual learning environment. When I consider how a learning environment affects teaching and learning and is it possible to measure effect and other objectives? If I try to find out answers to the question, then I can point out Buy (2001), who considered the following problems:

a) A virtual learning environment will lower the rising costs of higher education,
b) Students learn at least as much in a virtual learning environment as they do in traditional classrooms,
c) Individual learning through a virtual learning is inherently less effective than learning in live courses,
d) There is no significant difference between the effectiveness of a virtual learning environment and traditional instruction,
e) A virtual learning environment will blur the distinction between academic education and professional training.

It is worth noting that is impossible to produce statistically significant research results in comparisons, since the situation cannot be organized adequately, even if one tries to use the same course material, same teachers and same learners.

3.3 Learning methods, models and styles

In Section 3.3, I survey how learning methods, models and styles are studied. The purpose of the sub-section is to provide a vision of how different types of learning may have an effect, and should be considered when trying to construct an evaluation method. Learning processes are studied by using individual learner, a group of learners, and an organization as a learning object. In sub-section 3.3.1, I concentrate to describe individual and group learning processes. In sub-section 3.3.2, I describe qualitative and quantative knowledge concepts, which are based on Biggs and Collis (1982) idea of learning outcomes. In sub-section 3.3.3, I describe three learning

methods and in sub-section 3.3.4, I try to describe organizational learning process can be presented using by Maes et. al.'s (1999) model as an example. In sub-section 3.3.5, I explore the collaborative problem based learning method.

3.3.1 Kolb's experiential learning cycle

Kolb's experiential learning cycle is selected, since it can describe how the teaching processes should be arranged in polytechnic, in which teaching is practice oriented or it should be in this way organized that students can engaged in teaching process and try to solve real-world problem. Kolb's learning cycle can reveal how an individual learner may use knowledge and how she/he is willing to share knowledge with other learners in a learning group. The experiential learning theories include more than one learning process and four learning styles Kolb (1984). The following learning styles and learning steps are used to identify Kolb's experiential learning cycle.

1) Concrete experience,
2) Reflective observation,
3) Abstract conceptualization, and
4) Active experimentation

Kolb's learning cycle includes learning styles, which are a combination of two learning steps:

Accommodating (Concrete experience and Active experimentation)
Assimilating (Abstract conceptualization and Reflective observation),
Converging (Abstract conceptualization and Active experimentation) and
Diverging (Concrete experience and Reflective observation),

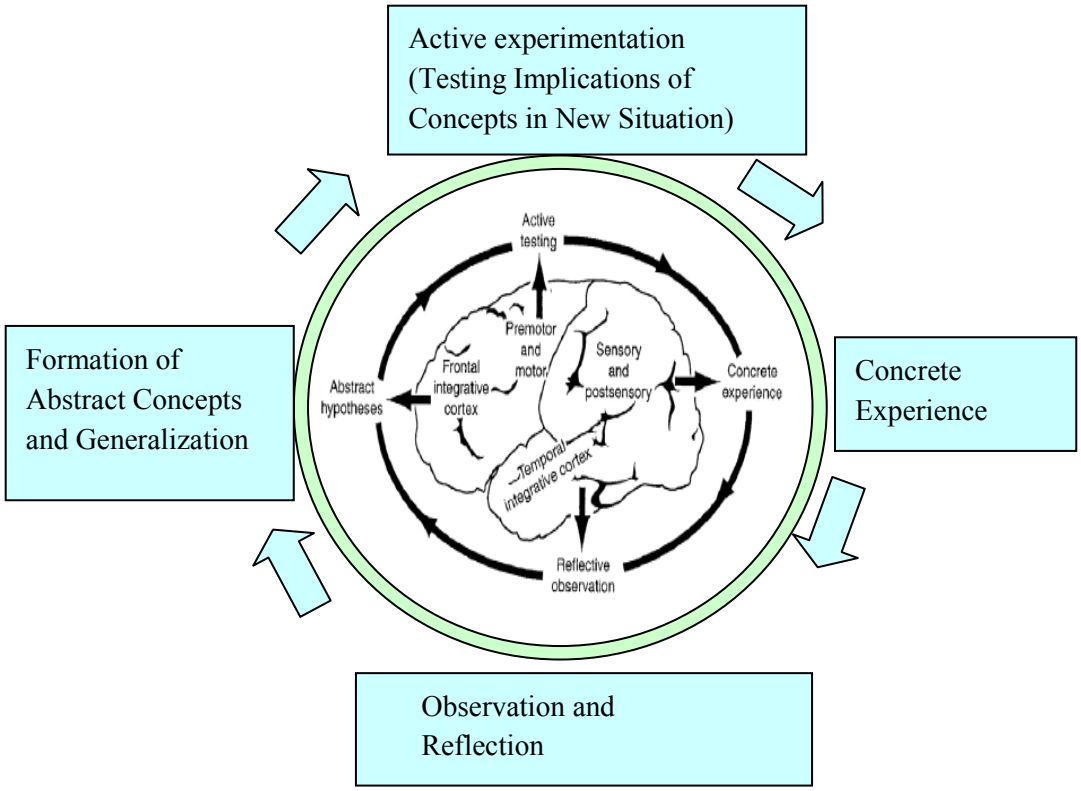

Figure 3.5 The experiential learning cycle and learner's cerebral cortex (Kolb and Kolb 2005)

A slightly modified Kolb's learning cycle is presented in Figure 3.5. Kolb and Kolb (2005) emphasize the link between learning style and the brain functioning. According to Kolb and Kolb, Zull (2002) put together the brain region and Kolb learning cycle's components. By exploring experiential learning cycle and by trying to describe the learning process inside the mind, I try to visualize how the learner may adopt, copy, creat and build knowledge during a learning process. Kolb argues that learning consists of two dialectically related processes. The first is the process of transforming concrete experience and abstract conceptualization, and the second is reflective observation and active experimentation.

To summarize the discussion of the Kolb's learning cycle and its learning styles, I point out that the relationship between Kolb's learning styles and online learning has been studied recently (Lu et al., 2007 and Akkoyunlu and Soylu, 2008). It is a fact that relationship between Kolb's learning styles and online learning environment has been reported with confusing outcomes in earlier studies, as Lu et al. pointed out. Lu et al. studied relationship between Kolb's learning styles and the enduring time of online learning behaviours, the relationship between Kolb's learning styles and learning outcomes. Lu et al. found a significant effect of learning styles on total reading time and total discussion time. Students, who were recognized as Convergers and Assimilators spent more time online reading than Divergers and Accommodators, who instead used more time in online discussions. However, learning styles had no significant effect on learning outcomes. As suggestions, Lu et al. proposed that facilitators and instructors should seriously consider the different learning styles, when they are preparing online learning modules. Further more Lu et al. considered whether we should design online learning modules to meet the students' need of different learning styles, and concluded that the answer is not clear, it is merely arguable. Akkoyunlu and Soylu (2008) examined students' views on blended learning environments questioning if there are distinguishable differences of students' views with respect to their learning styles. They suggested that learners' learning styles are important to know when designing e-learning environment.

A blended learning environment in Akkoyunlu and Soylu's research was a combination of face-to-face and online learning. Both, Lu et al. and Akkoyunly and Soyly used the online learning environment. It is good to recognize that online and virtual are used to denote computer supported learning. I argue that these can be used as a synonym. However, I prefer to use a virtual learning environment and virtual learning application.

3.3.2 Qualitative and Quantitative knowledge in learning

It is interesting to consider, how qualitative and quantitative knowledge should be integrated to the concrete situation. Brown, Collins and Duguid (1989) argued that the conceptual knowledge is understood in connection of its use in a real situation. They suggest (p. 35) that students are reasoning with laws and are acting on symbols. Students are resolving well-defined problems. Students are producing fixed meaning and immutable concepts. Brown, Collins and Duguid suggested that practitioners are using causal models. Practitioners are acting on conceptual situations. Practitioners are solving ill-defined problems. Practitioners are producing

negotiable meaning and socially constructed understanding. Compared to students' and practitioners' learning activities, Brown, Collins and Duguid recognized clear differences. These differences are valuable when I consider features of virtual learning.

Biggs (2003) suggested that learners are constructing meaning through relevant learning activities. Biggs argued that learning activities should be considered with the teacher's and learner's perspective. Biggs assumed that learning objectives are best described by using verbs that create a knowledge hierarchy from the lowest level to highest. The idea of a knowledge hierarchy is based on the structure of the observed learning outcome (SOLO) developed by Biggs and Collis (1982).

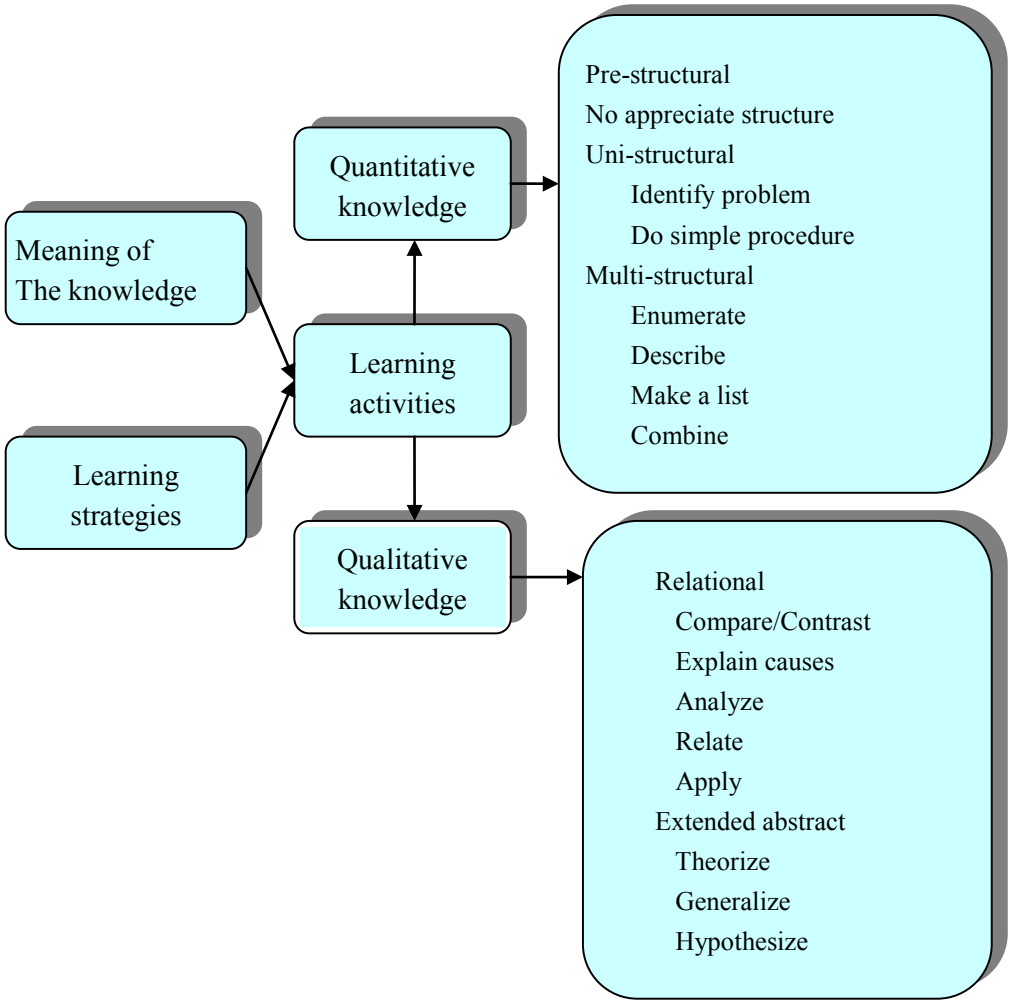

Figure 3.6 Quantitative and qualitative knowledge and outcomes of learning process

In Figure 3.6, I try to figure out this knowledge hierarchy. The learning strategies and activities in Figure 3.6 are based on our own thoughts after identifying how quantitative and qualitative knowledge can be identified during learning processes and how the thoughts will be linked to the collaborative problem based learning method. The quantitative knowledge and qualitative knowledge are based on Bigg's consideration. Khalifa and Lam (2002) used the structured observed learning outcome, when they carried out a study of learning effects on web-based learning application. Khalifa and Lam's research framework included the classification of the

learning outcome, namely the declarative knowledge and the structural knowledge. Anderson (1983) defined the concept of declarative knowledge. The declarative knowledge is divided to the episodic and semantic knowledge. Episodic knowledge is knowing about things (where, when, who, etc.), while semantic knowledge is known the meaning of the words. The structural knowledge is needed for problem solving processes. It can be also mentioned procedural knowledge, the concept that is used when we describe tasks or jobs. Biggs and Tang (2007, p. 72) defined also that declarative knowledge is "… knowing about things". Biggs and Tang point out that declarative knowledge are used to solve problems, designing things and planning. Teachers and learners can utilize declarative knowledge for problem solving, when they have solid foundation of knowledge.

It is also worth noting in comparison, Biggs and Collis' structure of the observed learning outcome with Lundh Snis's (2002) codified knowledge: understanding practice, improving practice, mediating practice and facilitating communities of practice, and in comparison with Orlikowski's (2002) practices: shared identity, face-to-face interaction, aligning effort, learning by doing, and supporting participation. I assume to that similarities exist between these concepts, when I consider the learning situation, where learners are acting together.

As a conclusion of individual learning, I figure out that the structure of reversed hierarchy of knowledge proposed by Tuomi (1999) includes the features, which I should recognize, when I try to identify the properties of a virtual learning application. It is true that the cognitive domain includes more learning methods than is included here, e.g., Bloom's (1956) taxonomy and its modifications could be interesting to survey. Anderson revised Bloom's taxonomy and changed the names of categories to the verb form (Anderson and Sosniak, 1994). The new categories are the following from top to down creating, evaluating, analyzing, applying, understanding, and remembering. In the Bloom's taxonomy, the knowledge dimensions are the factual, conceptual, procedural, and meta-cognitive. Comparison Bloom's revised taxonomy with Biggs and Collis' taxonomy reveals that the first and the second knowledge dimensions include similar verbs in comparison to quantitative knowledge in Biggs and Collis. The meta-cognitive knowledge compared with qualitative knowledge includes activities that are close to each other, but the categories are overlapping.

I believe that a learning process is essential to consider, when I try to define meaningful features of an ideal virtual learning application. My belief is based on over ten years teaching experience and usage of the problem based learning. Therefore, I have surveyed the individual learning process and learning activities.

3.3.3Three learning methods

In this sub-section, I survey learning models that are an objectivist, collaborative, and constructivist. The purpose is to draw a basic knowledge of these models and to provide some argumentation about why in this study it is also necessary to identify the learning model. I assume that different learning models need a different kind of virtual learning application. It has been shown that objectivist i.e. teacher-centred virtual learning is a simple website that is used to distribute learning materials. An interactive website needs a different kind of virtual learning

application as Khalifa and Lam (2002 proposed. The collaborative problem based learning includes certain properties that have to be recognized while designing a virtual learning application. For example, the project computer supported intentional learning environment (CSILE) produced the Future Learning Environment (FLE) (see http://fle3.uiah.fi), which is suggested as the best solution for different kinds of group learning; project based learning, research based, problem based learning.

A short survey of learning theories and learning models reveals that at least four metaphors for knowledge building exist. Sfard (1998) presented acquisition and participation metaphors for learning. Paavola, Lipponen and Hakkarainen created the third, the knowledge creation metaphor (Paavola et al. 2004; Hakkarainen et al. 2004). The fourth, the trialogical learning metaphor is constructed based on the knowledge creation metaphor developed by Paavola and Hakkarainen (2009). The basic idea seems to be a dialog between three persons, who are constructing some shared objects of activity within social and/or cultural setting. The shared objects are items, which can be connected to Poppers (2002) III world ontology. However, I do not consider these metaphors any further. The knowledge practices laboratory projects website includes more information about knowledge building (http://www.kp-lab.org), and this project is interesting for this research perspective, because the focus of the knowledge practices laboratory is to create an innovative learning system. According to the project web site: "...KP-Lab project design and implement a modular, flexible, and extensible ICT system that supports pedagogical methods to foster knowledge creation in educational and workplace settings. The system provides tools for collaborative work around shared objects, and for knowledge practices in the various settings addressed by the project."

I try to draw a vision in Figure 3.7 on how I think these three learning models can be integrated to the learning process. Learning methods as an objectivist, a collaborative and a constructivist are included to denote different learning strategies, and virtual learning applications are used to prepare, create, build, and process knowledge. The basic idea is to clarify an assumption that in the reality, a virtual learning environment and its components can be used at the learning situation. However, I emphasize that from this study's perspective, this consideration concentrates on collaborative learning. It is true that in the real learning situation, overlapping between learning methods, and used knowledge tools exist.

Objectivist learning models are utilizing computer-based learning tools in a way where teachers are transferring data (knowledge) to learners in digital format. I argue that a teacher-centred learning model (objectivist) means that learners are passively following instructions and using learning material that is made available on the server and the virtual learning application is used only as a distributing tool for learning materials. The properties that are essential for this kind of teaching and learning are quite simple. I point out that the network connection and server are needed for to save learning materials and data are used with shared folders.

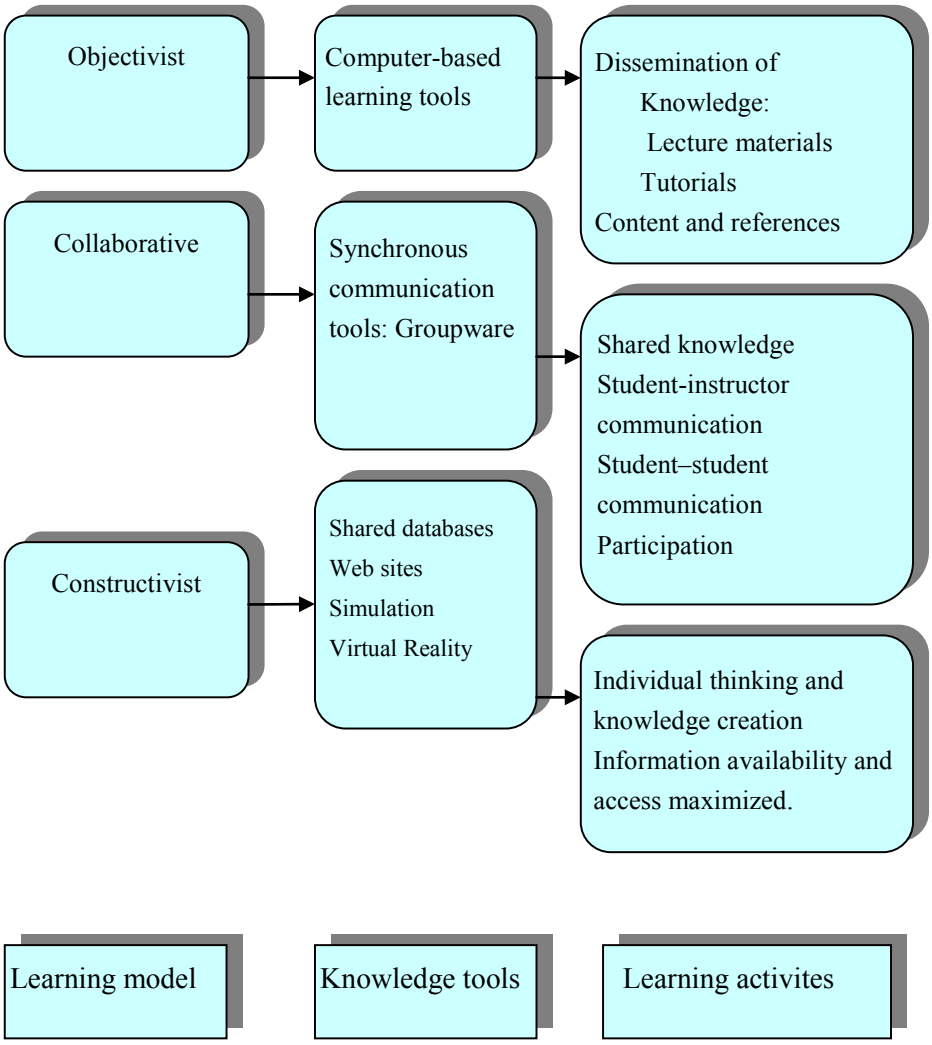

Figure 3.7 Learning models and information tools and learning.

The Information Systems' researchers Leidner and Jarvenpaa (1995) defined teacher-centred and student-centred learning models. Their models are based on the constructivist approach. It should be kept in mind that Leidner and Jarvenpaa are not professionals in the educational research area even though the article is widely used as a reference for learning methods.

Leidner and Jarvenpaa (1995, p. 270) defined five learning methods:

1) *Objectivism,*
2) Constructivism,
3) Collaborativism,
4) Cognitive Information Processing, and
5) Socioculturism

Leidner and Jarvenpaa's definition includes the following dimensions:

1) the learning method,
2) the realism of context,
3) the control of the learning environment and
4) the knowledge type

I take Leidner and Jarvenpaa's (1995, p. 266) following statements. Firstly, "learning models are often classified as being behavioural or cognitive." They also point out "objectivism, also referred to as the traditional model of learning, is the behavioural model of learning and represents a traditional view of learning. The primary competing cognitive model is constructivism. The socioculturalism model shares some assumptions and goals with constructivism, but challenges some others."

Leidner and Jarvenpaa (1995, p. 284) proposed the following terms to identify technology in the teaching processes.

a) automating,
b) informating up,
c) informating down, and
d) transforming.

The purpose of Figure 3.8 is to describe the connection between ICT tools and the learning process. The arrow between the virtual learning environment and teacher-centred learning is automating the process, pointing to knowledge transfer. The arrow between virtual learning environment and student-centred learning denotes both informating up and informating down. The arrow between student-centred learning and individual learning describes the transforming processes. The arrow between student-centred learning and group learning describes transforming and informating down. The group-learning situation teacher and learners are interacting and creating knowledge together. By emphasizing knowledge creation and knowledge building processes, I see that virtual learning environment supports merely for creating and building knowledge than knowledge transfer. The concept automating includes instructor console, stand-alone student computers, computer assisted learning, and distance learning by using these as a tools, Leidner and Jarvenpaa set some pedagogical assumptions how a learner can learn. The concept informating up is used to describe how teacher or instructor can get feedback and how a teacher can give feedback to the learners. The concept, informating down, denotes how learners can create knowledge by exploring information and creating knowledge structures. The concept transforming is used to denote asynchronous communication and distance learning at any time and at any place, it includes a groupware-supported asynchronous communication across distances.

By considering what transforming may mean, I point out that in education and cognitive disciplines the term knowledge transfer is considered as learning including individual and group learning (e.g., Brown, Collins and Duguid, 1989; Duffy and Jonassen, 1992; Lave and Wenger, 1991; Scardamalia and Bereiter, 1994; Senge, 1990). It is worth noting that Scardamalia and Bereiter used the term knowledge building, instead of knowledge transfer. If I think about individual and group learning processes, I emphasize that trying to find out a solution for a real-

world problem (or a real-life problem), the learners have to get knowledge, create and build knowledge, so the transferring knowledge might be too limited a concept.

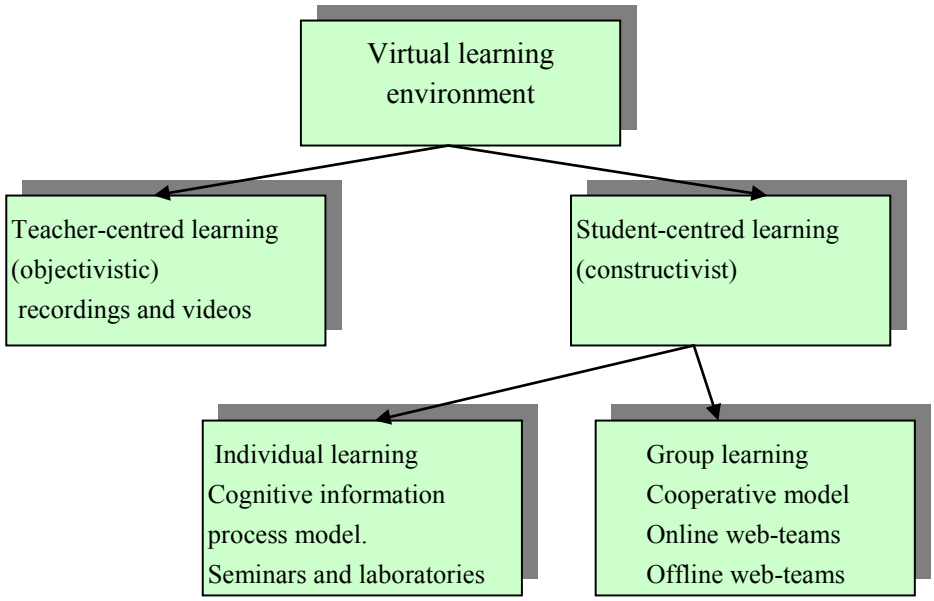

Figure 3.8 Learning processes in virtual learning environment.

Leidner and Jarvenpaa use the term learning theory instead of learning methods in their figure, even, when they are discussing learning models and use this term, and analyzing these models. In 1995, a general assumption was that integrating the Information and Communication Technology (ICT) to learning processes, learning organizations could automate and save costs, when applying virtual learning. After ten years, clearly assigning ICT to learning, this assumption is only partly true, hence, in reality, using ICT demands specialized skills so that ICT can be used effectively to support learning and teaching in formal and informal learning. Leidner and Jarvenpaa (1995) present the information tools that are used or can be used for learning and teaching. These tools are:

1) an instructor's console and stand-alone workstation of students,
2) computer-assisted instruction/the computer-based training (CBT),
3) distance learning, which is defined as a tool to transfer a course from one location to another,
4) email, which is defined as a tool to send and receive information between the instructor and learners,
5) a learning network, which is defined as networked workstations and shared databases: which link learning networks to the constructivist learning model,
6) hypermedia technology was considered at the time to offer new ways of using ICT in learning,
7) simulation technology and virtual reality were presented as a promising tool for learning and experiencing virtual reality in the classroom.

In Figure 3.9 Leidner and Jarvenpaa described learning methods starting from abstraction, in which objectivism is a typical learning method, in the middle collaboratism and constructivism are learning methods, and ending with a personally experienced learning method, which is labeled as socioculturism. The control of learning is changing from an instructor (teacher) to a learner, when knowledge creation processes via learning methods are changing. The learning method socioculturism is defined according to Leidner and Jarvenpaa (1995, p. 269): "... the sociocultural model is both an extension of and a reaction against some assumption of constructivism." and "... the major implication of socioculturalism is that students should participate on their own terms." The cognitive information processing is defined as "…another extension of the constructivist model and focuses on cognitive processes used in learning. Learning involves processingin structional input to develop, test, and refine mental models in long-term memory until they are effective andr eliable enoughin problem-solvinsgit uations." (p. 269). Further Leidner and Jarvenpaa (p. 270) identified that socio-cultural learning "action-oriented, socially conscious learners with the view to change rather than accept or understand society." Collaborativism is "... learning emerges through shared understanding of more than one learner."

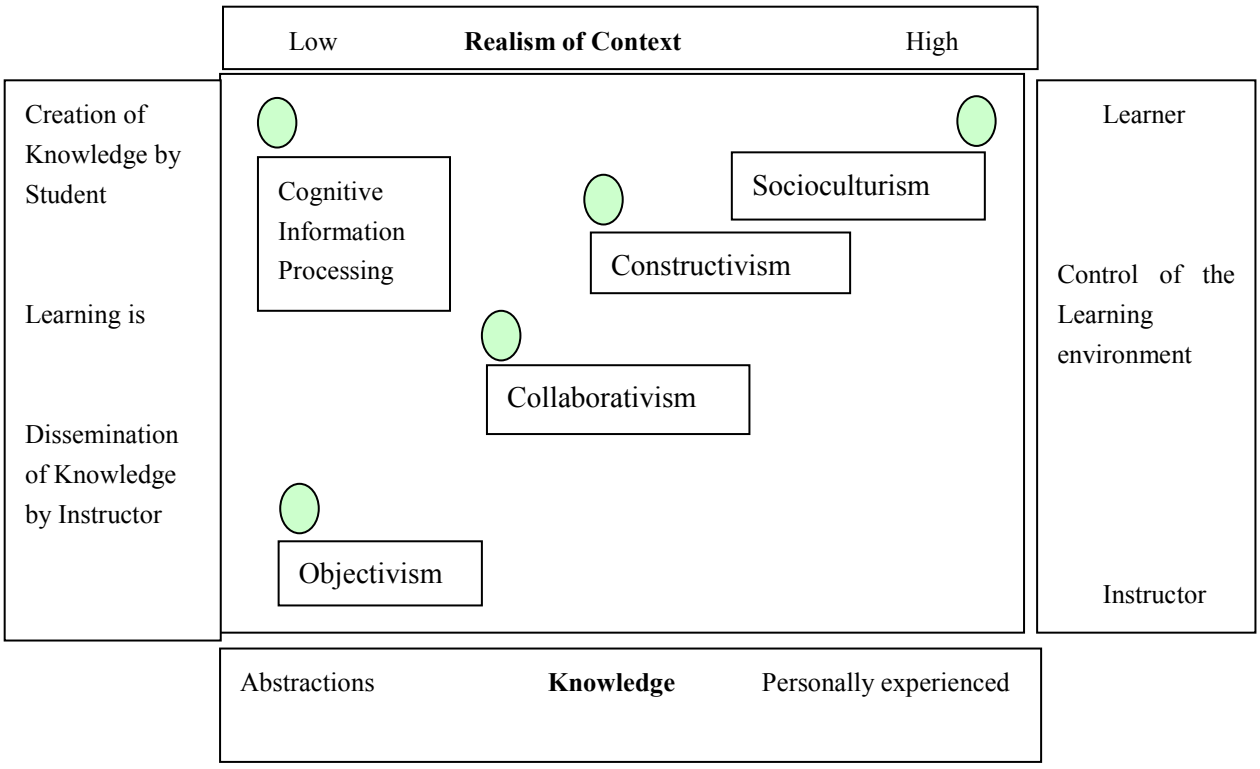

Figure 3.9 The dimension of the learning models by Leidner and Jarvenpaa (1995).

In Figure 3.9 on the horizontal dimension is knowledge, which is represented as an abstract and a personally experienced knowledge. I think that Leidner and Jarvenpaa see abstract knowledge in a way that is used as an objective knowledge in the cognitive information processes, and abstract knowledge is transformed to subjective knowledge via personal experience. In the learning processes a learner uses and transforms an abstract knowledge to the subjective knowledge by using his or her own knowledge and experiences of similar situations. However, it

is an open question, how a learner uses available knowledge in the new situation, when she or he is trying to solve existing problems. On the vertical dimension on the left, the knowledge creation process (learning) is disseminating the teacher's instructions and learning materials or learners are creating knowledge, and learners are controlling knowledge creation processes. In Figure 3.9, this is explained on the right side. At the highest level of learning is defined as "socioculturism".

3.3.4 A life-long learning in the society

On a very general level, it can be pointed out that the society organizes a formal learning and teaching infrastructure. It can be assumed that society sets the objective of learning in a hope that international competition and welfare can be achieved by using knowledge for better production and services in the future. I took Maes et al.'s lifelong learning model as an example, to show how higher education can be described at a society level. Maes et al. (1999) developed a model of life-long learning by sharing (LLLS) using the learning triangle, which is represented in Figure 3.10.

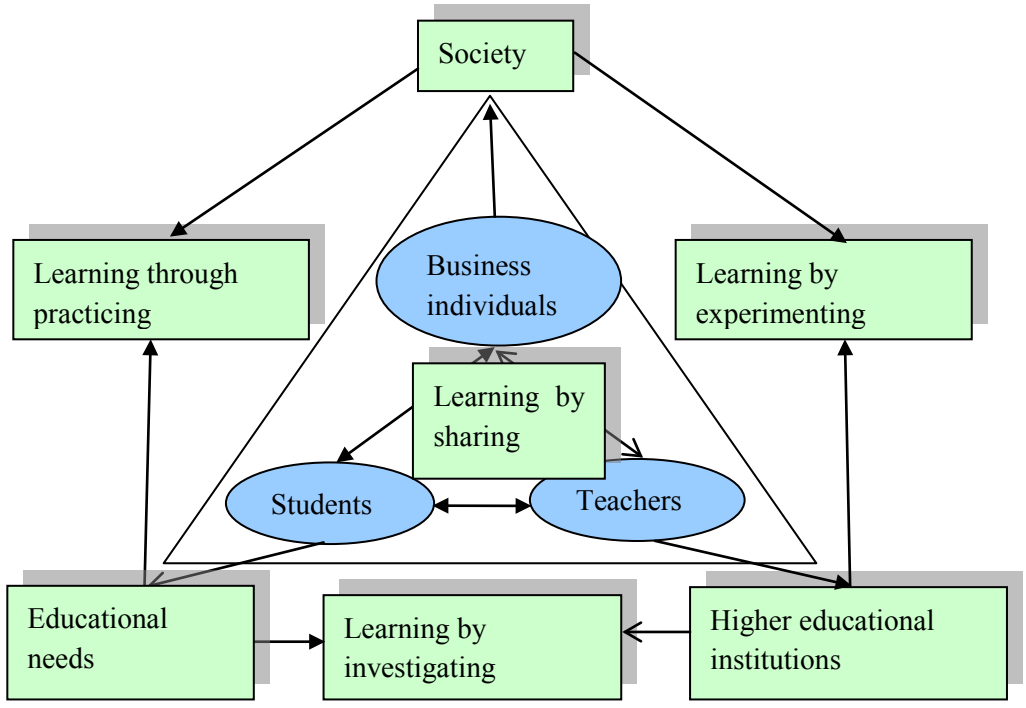

Figure 3.10 A model of the life-long learning by sharing (modified from Maes et al.)

Maes et al. (1999) argue that past learning methods in European universities are based on educators teaching knowledge by using their research outcomes as course materials. The learning method has been a single dimension from teachers to students, and the learning period has been assumed before working time. Maes et al. propose that their model of life-long learning

by sharing is multi-dimensional. The LLLS model does not explicitly include virtual learning environments or Computer Supported learning networks: the LLLS model is used to describe how I can understand formal and informal learning at a life-long learning context. I pay attention to virtual learning environments, and applications can be used in the life-long learning process in the different times. I assume that the learning by sharing includes at least implicitly, that knowledge sharing needs computer supported learning networks.

The basic premise of Maes et al.'s model is the cooperative learning model, and they use Leidner and Jarvenpaa's (1995) proposals "learning emerges through the shared understandings of more than one learner" and "knowledge is shared as it is created, and the more it is shared, the more is learned" (1995, p. 268 and 270). The second premise is the constructivist-learning model that means that learning processes are student-centred and the learning is self-regulating, and the teacher's role are coaching and giving necessary feedback. Maes et al. (1999, p. 5) draw attention to the model of life-long learning by sharing and they describe learning on the meta-cognitive level, and this means that the model includes self-reflection for both participants - students and teachers. The model of life-long learning by sharing includes third participants, the business individuals. When business people take part in the learning process, they offer a real time link to current practices in the business life. Introducing the three parties, (extra party) is a new way to develop a learning triangle. The description of life-long learning by sharing (LLLS) can be done by describing the links between educational needs, and the learning by investigating, and the higher educational institutions integrate these three parties together that students, teachers, and the business individuals can work as part-time lecturers. In this study, business individuals are not included to the evaluator group.

The collaborative working method for teachers and business individuals means that they can combine the outcomes of results and practitioners' experiences of the curriculum and course contexts: the practitioners can then utilize the best outcomes of the research that is carried out by the teachers and the researchers. Students can learn work practices during their work exercise periods, and combine learning and working experiences and add to their knowledge and problem solving skills. The role of information and communication technology (ICT) is seen as a supportive tool by Maes et al. (1999, p. 10-11). They stress that by using ICT it is possible for all parties to access data, it makes it possible to give online feedback, and it is possible perform parallel learning. They argue that a multi-perspective learning is enabled different types of settings, for example, simulation, and using the virtual reality to transfer knowledge.

Maes et al.'s learning model includes business individuals, who presumably participate in learning and teaching process by providing real business life experiences and offering real life learning cases for students. I pay attention to this assumption, thus with our own experiences, it is from time to time very difficult to get business individuals to actively participate in teaching. However, Maes et al.'s model of life-long learning by sharing is interesting learning model, since it includes four learning processes: a) learning through practicing, b) learning by experimenting, c) learning by investigating, and d) learning by sharing. Maes et al.'s learning processes can be also named as learning styles.

By trying to apply the model of life-long learning to Finnish higher educational institutions, it can be pointed out that according to the Ministry of Education: "Polytechnics train

professionals in response to labour market needs and conduct R&D which supports instruction and promotes regional development in particular." (www.minedu.fi). Where as "The mission of universities is to conduct scientific research and provide instruction and postgraduate education based on it." According to the mission of both educational institutions, the model of Maes et al. can be used to visualize Finnish educational institutions. In the reality, the vision and mission describe more the future situation than how it is today.

Ministry of Education uses the term 'Polytechnic'. The Rectors' Conference (ARENE) proposed the translation 'university of applied science' (ARENE, 2007). Vuori (2011, pp.21 - 22) considered this situation and emphasized that also in other European countries are using different translations. I will use polytechnic and university of applied science as the synonym.

3.3.5 A collaborative problem based learning

In this sub-section, I explore collaborative problem based learning. I emphasize that sophisticated virtual learning applications are needed for synchronous and asynchronous communication tools, and learners can share learning materials and knowledge concerning specified subjects in the learning sessions. Active participation via a network is then an essential part of students' learning processes. A collaborative learning model is utilizing interactive computer-based learning tools and learners are sharing knowledge with a student - student interaction, and teacher's role are as an active questioner and if needed a discussion leader.

Multiple definitions of collaborative learning and cooperative learning exist. I selected to use Johnson, Johnson and Smith's (1991) summarization of collaborative learning: "First, knowledge is constructed, discovered, and transformed by students. Faculty creates the conditions within which students can construct meaning from the material studied by processing it through existing cognitive structures and then retaining it in long-term memory where it remains open to further processing and possible reconstruction. Second, students actively construct their own knowledge. Learning is conceived of as something a learner does, not something that is done to the learner. Students do not passively accept knowledge from the teacher or curriculum. Students activate their existing cognitive structures or construct new ones to subsume the new input. Third, faculty effort is aimed at developing students' competencies and talents. Fourth, education is a personal transaction among students and between the faculty and students as they work together. Fifth, that all the described learning can only take place within a cooperative context. Sixth, teaching is assumed to be a complex application of theory and research that requires considerable teacher training and continuous refinement of skills and procedures" (p.1:6).

The collaborative problem based learning (CPBL) according to Kwock et al.'s (2002) at least implicitly includes an assumption that learners have enough of their own experience to be able to convert their tacit knowledge to common ideas. It is worth noting that Nonaka et al.'s studies are concentrated on organizational informal learning and an experienced learner's way of using tacit knowledge in everyday work. Cook and Brown (1999) used Polanyi's (1969,1986) work in their research, and they claimed that "it is important not to mistake using one form of

knowledge as an aid in acquiring the other with one form being 'converted' into the other. Tacit knowledge cannot be turned into explicit, nor can be explicit knowledge be turned into tacit". Cook and Brown used physicians and technicians in their study, and their claims are based on the findings of that research.

The knowledge types can be identified by using Alavi and Leidner's (2001) knowledge taxonomy. The following knowledge types: tacit, explicit, individual and social can be utilized in learning processes. From the learner's perspective, the knowledge can be recognized depending on the learning situation. Tacit knowledge is action oriented and arises from the learner's experience and it can represent mental models. Explicit knowledge is from the learner's point of view, learning material. When I explore knowledge by using a learner's lens, I recognize that the individual knowledge is created and exists in the mind of the individual. When I try to utilize social knowledge, I can propose that the social knowledge is utilized in discussion between members of the group and inter-group discussions. The knowledge types: declarative, procedural, causal, conditional, relational and pragmatic can be recognized in the learning process by arguing that declarative and pragmatic knowledge are available, when a learner tries to find out, what knowledge is available and if that knowledge is useful in the specific learning process. The procedural, causal, conditional and relational knowledge can be used when a learner tries to solve learning problems by asking the following questions: why, how, when knowledge is related to learning problem in question.

Orlikowski (2002) identified, in her study in the Kappa organization, that innovative organization members use practices that she named *shared identity*, *face-to-face interaction*, *aligning effort*, *learning by doing* and *supporting participation*. According to Orlikowski, shared identity and face-to-face interaction generate knowing how members can be coherent, committed and aligning efforts and learning by doing and support participation by helping members to organize and to coordinate complex projects. Orlikowski pinpoints that accepted practices create knowledge how to innovate within a global organization. Orlikowski's findings should take into account in education. Therefore, these practices can be used to organize the problem based learning sessions and aim at committing learners to study real life problems.

According to Lundh Snis (2002) a knowledge creation process includes interplay between implicit (tacit) and explicit knowledge. She defined that information is *codified knowledge.* Therefore, I propose that in a learning and a teaching situation, a person, who codifies knowledge can be teacher, tutor and student, and others (including teachers, tutors and other students as members of learning group) can utilize codified knowledge, when reading and using knowledge for solving problems. Teachers, tutors and students can apply knowledge by practices identified by Orlikowski (2002) and use a virtual learning application as a tool for to transfer knowledge between members of learning group.

3.5 Summary

To summarize this chapter, I conclude that the virtual learning environment and its components are surveyed and the research object is defined. The research object is an evaluation method for virtual learning application.

The definition of a virtual learning environment *includes hardware such as servers, workstations, network devices, printing and scanning devices and networks. It includes software such as operating systems, database systems, and it utilizes Internet services and browsers. A virtual learning environment consists of learning application, learning management system, content producing applications, a content management system, and virtual learning platform.*

The definition of a virtual learning application *is used for sending, receiving and transmitting learning instructions and learning material between tutor and students, where students can share their own digital material by using a virtual learning application.*

The learning processes are also studied and in this study, I use the following definition to describe learning with a virtual learning environment, how learners and teacher can use a virtual learning application. A learning model that I apply in this research is the collaborative problem based learning, whose features and properties I will use as a part of the evaluation objects.

A learner can utilize a virtual learning application for transferring, creating and building knowledge. A teacher can use it by transferring knowledge, interacting with learners and creating and building knowledge. A group of learners can share, create and build knowledge by utilizing virtual learning applications and other components of virtual learning environment.

Chapter four

4 Exploring IT/IS evaluation methods and evaluation criteria

4.1 Introduction

The evaluation research process is described by using the structure of design research process. The current stage box's background colour is darker than other states.

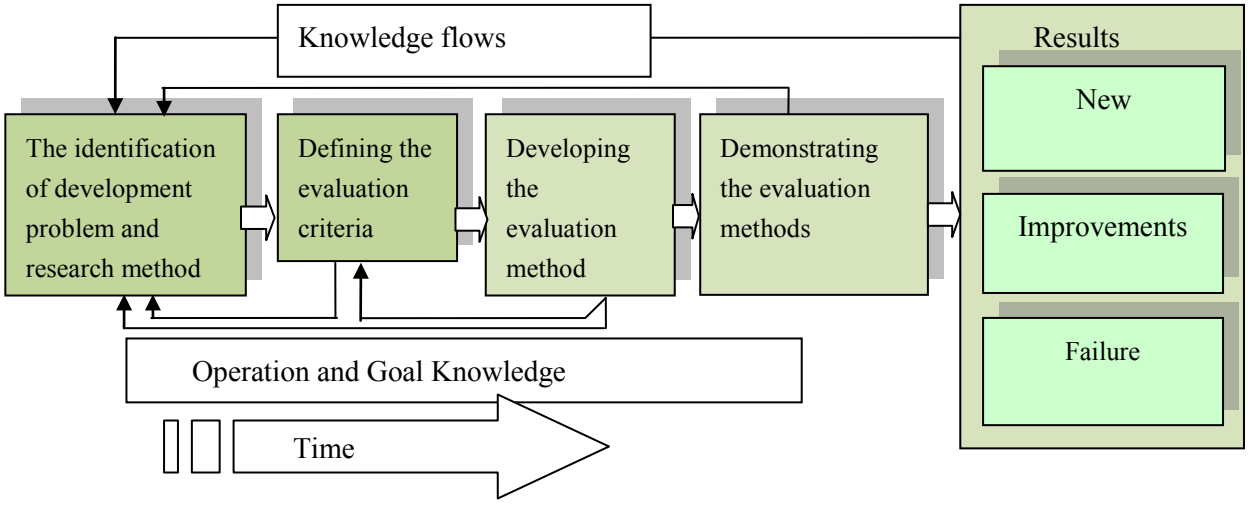

Figure 4.1 The structure of evaluation research process

In Section 4.2, I will analyze decision makers' roles and the role of a member of an evaluator group. Stakeholders' different roles, multiple objectives and preferences are identified in many evaluation research papers. Sedera et al. (2004) investigated Enterprise System (ES) users and identified that stakeholders' expectations and user satisfactions are based on roles in an organization. Executives, as enterprise system's users, have different expectations, in comparison to expectations of users at an operative level. Anthony (1965) introduced an organizational structure by defining it strategic, tactical and operative levels. Järvinen and Kerola (1975) used the same organizational levels, when they identified information systems in an organizational context. Seddon et al. (1999) proposed that evaluator's roles are independent observer, individual user, work group, management, and country. Smithson and Hirschheim (1998) proposed that evaluation should be carried out at different organizational levels. I investigate different roles of decision makers by analyzing types of decision, since I assume that results of evaluation used in decision-making may depend on the type of decision. The conceptual model of research area and roles of stakeholders are developed in this section.

In Section 4.3, I explore strategies for information system evaluation. Cronholm and Goldkuhl's evaluation strategies are goal-free, goal-based and criteria-based and information systems.

Section 4.4 investigates different types of evaluation methods in Information Systems. A general view of evaluation methods is presented by using literature review (Hirschheim and Smithson (1988); Berghout and Remenyi (2005); Irani and Love (2002, 2008). Berghout and Remenyi's investigation of evaluation theories is an excellent source for evaluation method research in Europe. Irani and Love (2002, 2008) investigated evaluation research and identified taxonomy of evaluation methods, which is used as background information in this study, when I try to develop an evaluation method for a virtual learning application.

In Section 4.5, I explore commercial off-the-shelf evaluation methods, which were developed in the past decades, and proposed for use in evaluation and selection processes.

In Section 4.6, I investigate Kaplan and Norton (1996) the Balanced Scorecard as a model, which could be used too as a source to develop an evaluation method for a virtual learning application. The Balanced Scorecard model is described, since it is used in evaluation research for engineering educational systems.

In Section 4.7, the updated DeLone and McLean (1992, 2003) IS success model is investigated and Alter's (2002,2003a/b) work system theory is adopted to the conceptual evaluation method for the virtual learning application.

In Section 4.8, multi-attribute decision models and AHP-method are described. The AHP-method Saaty (1999) is analyzed, since it is used for calculation of evaluation results in this study. The AHP-method is described, by using specified stakeholder groups and the relationships of evaluation criteria are presented and linked to virtual learning applications. Johansson and Johnson's (2005a/b) ATD model is presented. Wohlin et al.'s (2003a/b) multi-attribute project success model is presented, because they used the AHP-method for calculation.

4.2 Roles of decision makers and evaluators

In this section, I will investigate the stakeholders' role in an evaluation process. When I explore roles of different groups of stakeholders, I should recognize that each member of the group can understand concepts and terms differently, which can make it difficult to achieve a shared opinion. A member of the group may consider what the aims of an evaluation process are, and what the role of each member of the group is. I assume that each member of stakeholder groups has different experiential background and knowledge, what usage of virtual learning environment and virtual learning application means, so communication inside the group and between the groups is essential.

The stakeholders' roles need to be taken into account and the evaluation method should also include communication between groups and also communication inside the group between the

members of the group, since members can understand used concepts differently, so I should be aware of the concept gap dilemma too. Boland and Tenkasi (1995) have identified this problem, and they proposed communication and cognition to solve this problem, they recognized that boundary concepts are important, when discussing concepts and understanding the situation in question in a similar way and achieve the agreement about the used concepts. Decision-makers and evaluators face a decisive problem: the decision is rational/objective or it is subjective/political or somewhere in between. I will point out Burrell and Morgan's (1979) interpretive paradigm and Hirschheim and Smithson's (1988) evaluation continuum, where an efficiency zone, effectiveness zone and understanding zone are explored. Whittaker (2001) stresses that an information system should be effective, and the effectiveness zone is difficult to evaluate according to Whittaker (p. 60), because, the measurable effectiveness criteria are not easy to define. I emphasize that Whittaker only takes the following evaluation methods: cost-benefit analysis (CBA), expanded cost-benefit analysis, contingency techniques and user satisfaction models into account.

The concept of stakeholder and the stakeholder theory in information system research according to Pouloudi (1999) and Donaldson and Preston (1995) are described as instrumental and normative aspects of the stakeholder theories that should be taken into account. In this study, the stakeholder theory is used in an instrumental and normative meaning, since the groups of the stakeholder are used to define the requirements, and they are considered ethical issues in evaluation and decision-making. I point out that an evaluation method should include a) the analysis of decision makers and b) description of their roles during the selection process, since the purpose of an evaluation process is to produce proposals and suggestion for decision-making. Research in other disciplines has revealed that decision-making may mean different types of decisions, and it is valuable to try to investigate the various types of decisions can exist, and try to analyze how the role of decision makers may affect a decision. I developed a description of decision-making and types of decisions, which is represented in Figure 4.2. The types of decisions are the following: a) ad-hoc , b) organizational, c) political, d) rational and e) ethical decision-making.

The objective of each type of decision-making means that the decision maker tries to achieve different types of solutions. The basic assumption is that a rational decision maker tries to maximize the result, and an organizational decision maker tries to optimize the result, and a political decision maker tries to achieve a compromise and fit the result to certain situation and time. When the results are the compromise, I can assume that results satisfying for more than a single group of point of view. However, I decided that the organization theory and decision making models do not play a central role in this study, but they reveal that a decision maker's role and possible behavioural model are good to know, when trying to understand, why practitioners do not use advanced evaluation methods. Some polytechnics by the municipal owned may use political decision-making and follow rules and accepted decision procedures.

The decision-making models and the behavioural models are described in Figure 4.2 that give a general view of a decision-making process: it has to be admitted that presented models are not exhaustive, and in reality, different types of decision-making models can exist. The models that are selected to build a general view of the decision-making models are suitable for the purposes of this study. Other things that need to be described are how to make a choice and

after what kind of decision process the decision has achieved. The decision maker can decide after listening to others' opinion and arguments, or a decision maker can make the decision and inform others after making his or her decision.

Political decision-making models (PDM) include stages, where a decision maker follows rules and specified processes, after collecting and getting information concerning a situation, the decision is prepared and the decision maker makes a decision, and it is made public. After the announcement of the decision, other stakeholders can comment and propose their own opinions in a certain time-period and, if no notes have left, then a decision can be realized.

Organizational decision-making (ODM) includes groups that generate alternative decisions in which there are discussions concerning effectiveness and efficency. After the discussions, a decision is made and most of the members share and support the decision. Organizational decision-making includes communication and commitments, and it serves an important political function. The objective of the organizational decision-making process is to achieve optimized solutions. If the decision is compromised then an optimized solution is impossible, the solution is a compromise of stakeholders' opinions. Following rational decision-making assumptions made by Simon (1995), the decision process includes the following steps or stages: a) problem identification, b) creating alternative solutions, c) selecting a solution that satisfies (maximizes) results, d) making a decision and realizing it and e) evaluating a decision and achieved results.

Ethical decision-making models (EDM), when it is applied means that a decision maker has to think of ethical aspects that may be revealed soon when the evaluated information system is implemented. The ethical issues are difficult to recognize and describe in such a way that impacts can be taken into account in advance, before the decision. However, Whittaker (2001) following Habermas' emancipatory ethics (1984) emphasizes that a decision maker's duty is more valuable than the role in the organization. Mumford (1983a, 1983b) in her ETHICS method emphasizes the "fit" between what employees want, and what they receive …"; this 'fit" is important to take into account also in decision making, when evaluating the decision makers' role in evaluation and decision making. According to Mumford, the group role is important, when trying to achieve a solution that all participants can and are willing to accept. When 'objective evaluation methods' are used, then it is important that all stakeholders understand the assumptions and methods of evaluation metrics, otherwise the models are not used. Stahl (2007) criticizes Mumford's assumption about the current status quo and concerning power and coercion in the organization in question. However, Stahl emphasizes that Mumford's ETHICS method includes an assumption that employees and employers have a common aim and that the needs of employees and managers can be fulfilled at the same time as accepting the status quo in the organization.

The ethical issues are important to consider before implementing a virtual learning application, since teachers are naturally considering their roles as a teacher and their status in the future as a teacher, when virtual learning applications are installed and then used. The students also consider their roles as learners, and they investigate, how and in which way they can utilize a planned virtual learning support in their virtual learning.

Ad-hoc decision-making models (AHDM) are reactive in nature and a decision maker has to choose the solution with a limited amount of information or to use so called rules of thumb. The decision maker's roles doing ad-hoc decision is to solve ongoing problems. Simon (1978) uses the term "normative decision" and points out that this type of decision is not rational. Whittaker (2001) emphasized the decision maker's role 'get-the-job-done' as a mandatory, when the time schedule is tight and the decision has to be made in the limited time.

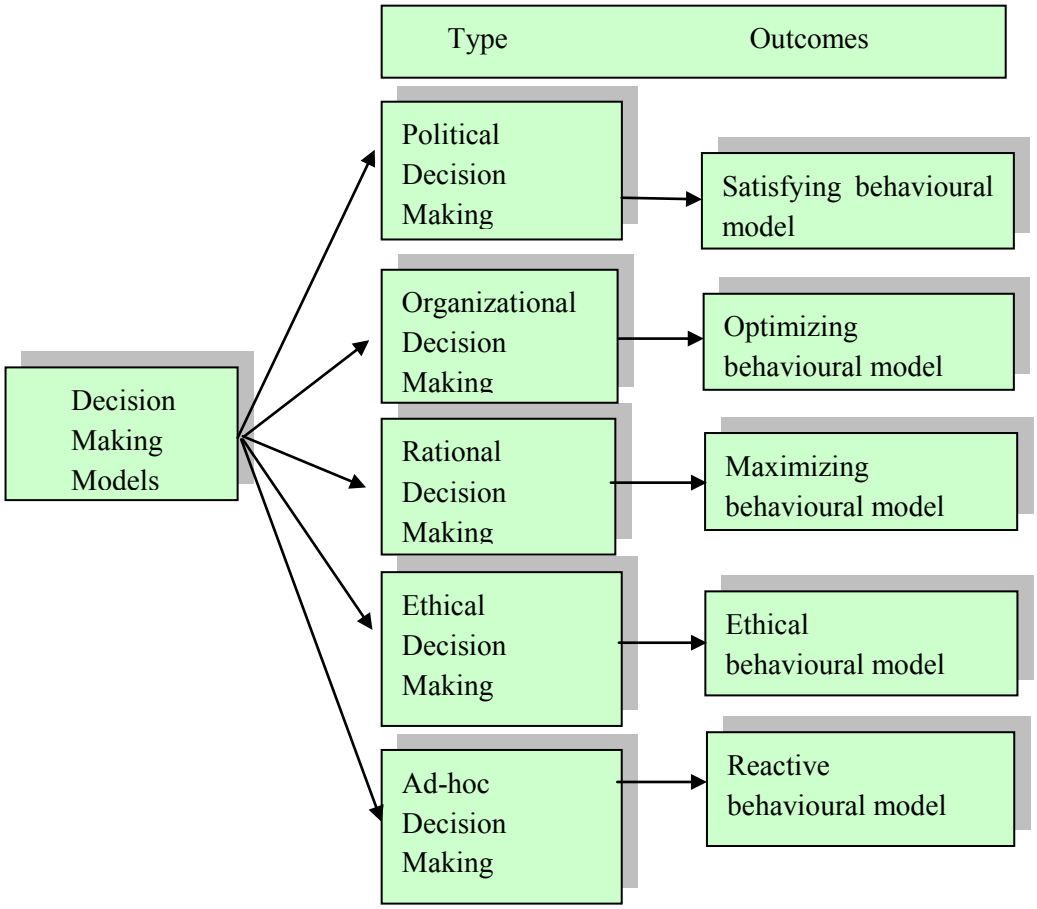

Figure 4.2 The decision-making models and decisions types.

The role of decision makers can be analyzed by using the three organizational levels. At a strategic level, the top management in the organization makes a decision according to the organization's vision, mission, and long-term main aims. The middle management operating at the tactical level tries to achieve short-term objectives by using available resources and tools. The decision makers at the operative level use the available knowledge and technology to get an operation carrying on smoothly and so that an everyday operation can be carried out and the outcomes satisfy the customers' needs.

I follow Whittaker's (2001) idea that a decision maker in a real life situation evaluates, an information system in a way that she or he 'gets-the job-done' as Whittaker defines the situation (p. 128). She stresses that "narrative, situated, pragmatic knowledge will be most useful in evaluation." I can accept Whittaker's idea, in a sense that in the starting phase of the evaluation process a discussion about preferences that will be accepted as evaluation criteria for different

stakeholder groups are needed. I do not accept Whittaker's augmentations that the discussion alone solves an evaluation problem, since in a real life decision situation, I pay attention to different types of preferences of the stakeholder groups, appropriate measurement and evaluation method are needed, which includes a usable metrics. The stakeholders' theory is used as an underlining approach to identify stakeholders that are represented in Figure 4.3. The stakeholder theory is adapted from the Organization and Management discipline to Information Systems. Turunen (2001) used the stakeholder theory in his study for health care information system evaluation and identified stakeholders into the following groups: users, managers, developers, patients, and outsiders and sub-groups are included each group (Turunen, 2001, p. 233). Cook (2004) emphasizes that an evaluator has to identify stakeholders, and he identified the following stakeholders: *Students, Lecturers, Developers, Support staff and Managers.*

I will in this study use the following stakeholder groups:

1. *top management as headmasters, deans, and directors (executives),*
2. *faculty members as professors, lectures, and teachers (teachers),*
3. *ICT staff as ICT-managers, developers (ICT-staff) and*
4. *Learners as undergraduate and adult students (students)*

At least one group that could be included is outsiders, but this group is not used in this research as an ex-ante research setting will be too difficult to take all possible groups in. The model in Figure 4.3 includes three organizational levels in the organization a) strategic, b) tactical and c) operational. Each level has its own objectives, and then it must be taken in the ex-ante, ongoing and ex-post evaluation processes into account and recognizes that these objectives can be conflicting with other stakeholders' objectives. I stress that producing proposals to select virtual learning applications means that evaluation method has to include the main objectives in each of the organizational levels.

Beer's (1981) Viable System Model (VSM) represents similar organizational levels. The Viable System Model includes rules, regulations, controls and auditing, which belongs to socially constructed reality. I argue that it is necessary to differentiate a general managerial decision making at the three levels, so that I can identify preferences for a virtual learning environment and a virtual learning application in a way that I can create evaluation criteria which include the organizational structure. The stakeholders, the level of organization and a general information systems' infrastructure, virtual learning environments, virtual learning applications and learning theory and methods are described in Figure 4.3. I created the figure to represent an evaluation situation that I am able to identify evaluation situation, and to show how the participants may have an affect in the evaluation process, and the objectives that are essential to be taken into account during the decision making.

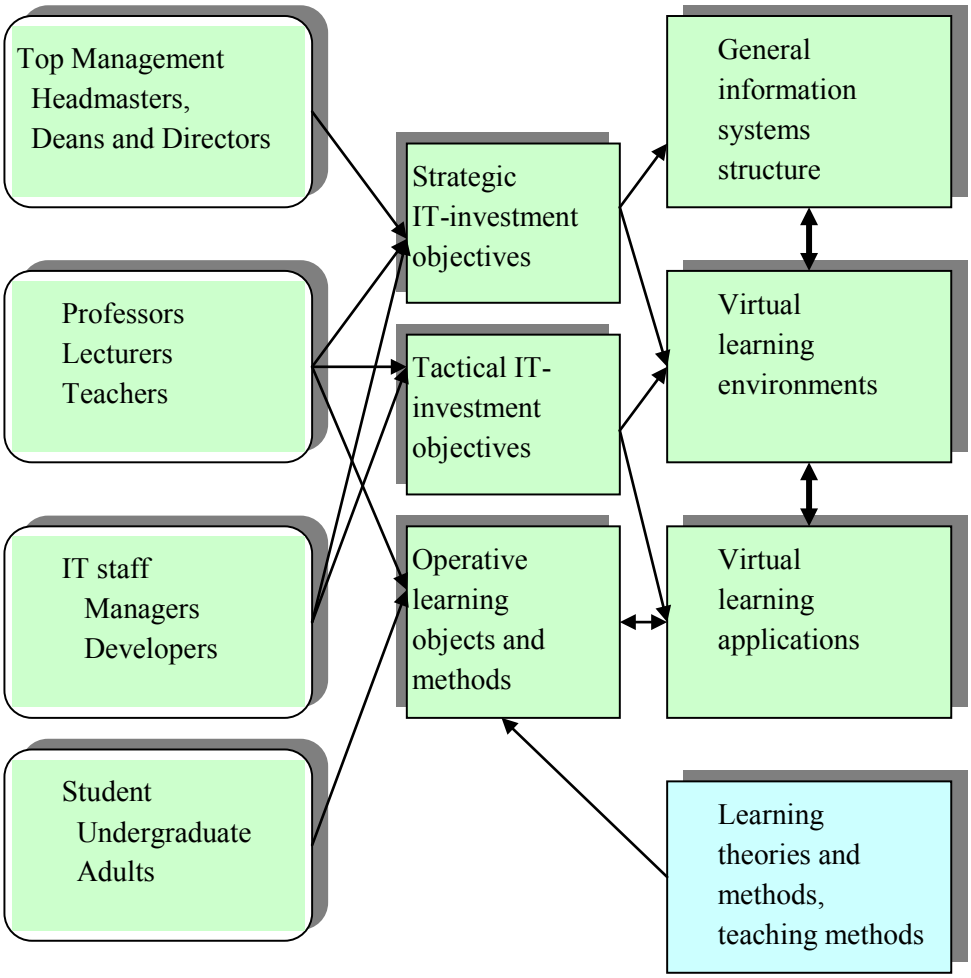

Figure 4.3 The conceptual model of the research area and the stakeholders' roles.

4.3 Evaluation strategies in Information Systems research

In this section, I will explore how evaluation strategies and the evaluation method have been investigated for software projects. I pay attention to ISO standards 9241 and 9126, which are developed for information systems. Some software companies integrated standards to their development process. They advertise ISO standards as a guarantee for their development process. ISO standards offer some quality features that all information systems should fulfil. I can point out these 'quality standards' should be taken into account in all information system projects including virtual learning applications. ISO 9241 and 9126 (ISO, 2008) standards define the following quality characteristics that should be taken in the account in the evaluation methods. The quality properties include: a) *functionality, b) reliability, c) usability, d) efficiency, e) maintainability and f) portability*.

In evaluation literature, the concept 'traditional evaluation technique' is used to describe cost-benefit types of evaluation methods. Gibson, Arnott and Jagielska (2003) used Irani and Love's (2002) argumentation that the traditional evaluation techniques are less suitable for the significant strategic benefits for the information systems. Irani and Love (2002) proposed a three level model of ex-ante analysis for IT investment, which is strategic, tactical and operational based on Anthony's (1965) structure. IT investment should be analyzed from at least three different points of view. From a managerial point of view, the three organizational levels offer a way to organize IT investment planning and evaluation so that the commitment of every organizational level can be achieved at the beginning of the planning period, the installation and use of the virtual learning application can be accepted. According to the organizational vision and mission, executives should think and analyze why and what kinds of applications the organization really needs.

Cronholm and Goldkuhl (2003a/b) presented strategies for evaluating information systems. Table 4.1 presents these strategies: *a) Goal-based evaluation, b) Goal-free evaluation and c) Criteria based evaluation.* The evaluation methods that are used are classified to: a) Deductive and b) Inductive method.

Table 4.1 Generic types of information system evaluation.

Goal type	IT-System as such	IT-System in use
Goal-free	Type1 Deductive Evaluator Expert	Type 4 Deductive Evaluator Expert and Users
Goal-based	Type 2 Inductive Evaluator Expert	Type 5 Inductive Evaluator Expert and Users
Criteria-based	Type 3 Deductive Evaluator Expert	Type 6 Deductive Evaluator Expert and Users

In Table 4.1, I recognize that Cronholm and Goldkuhl's classification for goal-free, goal-based and criteria-based includes minor problems, since the goal-based and criteria-based evaluation may need each others. Therefore, I stress that if I use criteria-based evaluation, I should also define a goal so that I am able to analyze the evaluation results against an organization's mission and aim. In theory, I can think that either goal-based or criteria-based evaluation exists and there is no need to combine the evaluation methods. The evaluators can be experts and/or users. Cronholm and Goldkuhl argue that there are four sources of data for evaluating the IT systems in use: the IT-system, the IT-system documentation, the observation of users, and the users' perceptions. Considering the IT-system, there are two main data sources for evaluation: the IT-system itself and the IT-system documentation, and in some cases, it might be possible to use users' perceptions.

Cronholm and Goldkuhl offer us two options, we evaluate the quality of system (IT-system as such), or we evaluate how useful the system is at the work (IT-system in use). The categories

are based on the goal settings, the system as such or the system in use. Cronholm and Goldkuhl identified that the evaluation methods can be inductive or deductive. According to Cronholm and Goldkuhl, a goal-based evaluation of an information system as such is a deductive type of evaluation. The main aim of deductive type of evaluation is to find out how well an organization's goal for usage of an information system has been fulfilled. Research data are goal descriptions, specification of requirements and description of an information system. An evaluation strategy for criteria-based evaluation of an information system is also a deductive type of evaluation. An evaluator can utilize features of an information system, descriptions of an information system. The main objective of criteria-based evaluation of an information system is to investigate the quality of an information system. To consider what a deductive type of evaluation method means, as defined by Cronholm and Goldkuhl, I can point out that they (2002a, p. 2) argued that "the basic strategy ... is to measure if predefined goals are fulfilled or not; to what extent and in what ways." The concept deductive is used here in its scientific meaning: logical reasoning. Cronholm and Goldkuhl idenfied that an inductive type of evaluation can be used, when evaluator(s) are exploring an information system in use and goal-based method is utilized, and experts and users are participating in an evaluation process. The main aim to use an inductive evaluation method is to find out richer information concerning an information system and its usage in the organization.

Cronholm and Goldkuhl create their generic evaluation methods by using literature analysis and from research data from Åkerfalk et al.'s (2002) empirical analysis. The generic evaluation method is based on theoretical thinking and the model is not tested yet. The Cronholm Goldkuhl-evaluation method offers a theoretical base to develop the criteria-based evaluation methods. This two dimensional model gave a foundation on which to study the virtual learning applications' systems before installation phase. The first dimension is called "How to evaluate" and the second dimension is called "What to evaluate".

4.4 Evaluation methods for information technology/information systems

By creating Figure 4.4, I try to identify an information system and its components that should be considered in an evaluation process. It can be claimed that in this study an evaluation process is targeted to the software dimension and to the users and stakeholders dimension. The hardware dimension is not included in the evaluation process, since it is included as part of the virtual learning environment and not as an element of the virtual learning application. The databases and data dimension are not included, because the data are a content of a virtual learning application, and it should be evaluated by using other types of evaluation methods.

When I consider an evaluation project, I have to explore how to investigate the value of information technology and/or value of an information system. For example, Bannister (2005) explored how to evaluate the IT-value and identified the following difficult questions:

a) The first category is the long-term impact of IT investment. Studies of the productivity paradox belong to this category,

b) The second category is the short-term value creating processes using IT. A typical research is a case study and methods that are used, are the return on investment or the Balanced Scorecard,
c) The third category is an evaluation study for a potential IT investment and the research question is; is the IT investment worthwhile for an organization or organization unit?

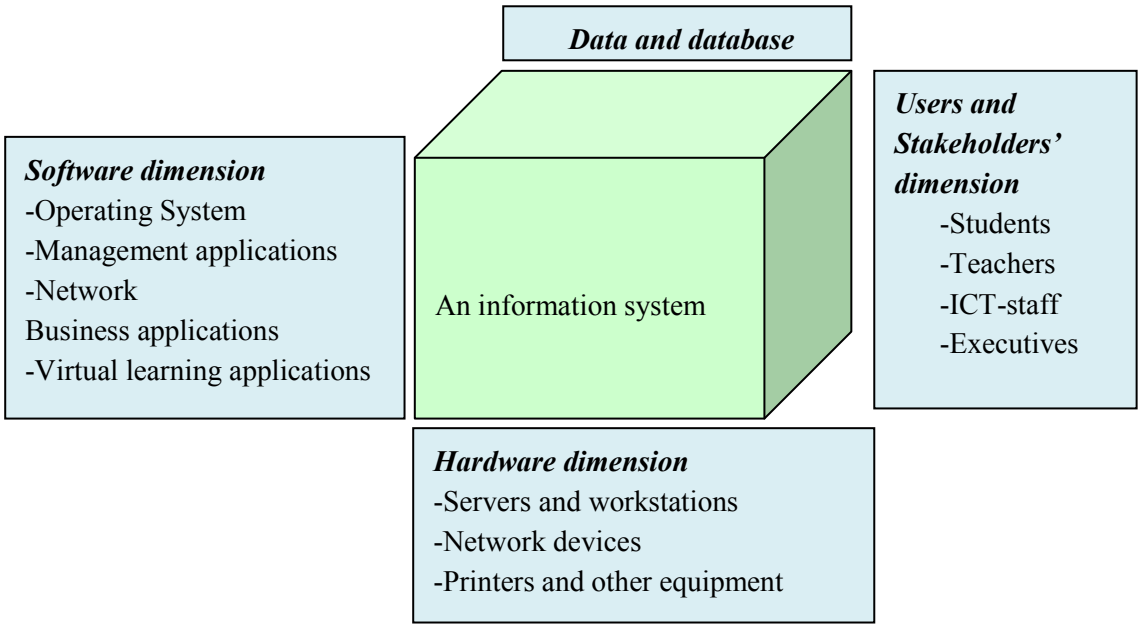

Figure 4.4 The four dimensional perspectives of an information system.

When I consider Bannister's first and second questions, I can classify IT investments to strategic, tactical, and operative investments. Decision-makers have to consider both long run and short run impacts of information technology and information systems. A difficult question is, when to start to utilize new information technology. The third question is difficult for decision-makers, since they should consider innovations for the information technology field and decision-makers should analyze which innovations are useful short and/or long run from the organizational point of view.

Kohli and Grover (2008) explored how an IT-value can be studied, and they argue that the first we should differentiate IT-value from the IS-value. Kohli and Grover defined that research for value of information technology must satisfy at least two conditions:

a) Information technology variable, variable of information technology management or manifestation
b) Endogenous variable with economic impact of information technology

They identified also to use the term information technology as a broader concept, and considered that value of information technology is impossible to investigate directly, but it must be researched indirectly. Kohli and Grover identified the following list of statements or themes:

1. Information technology does create value,
2. Information technology creates value under certain conditions,

3. Information technology based value manifests itself in many ways,
4. Information technology based value is different in comparison to information technology based competitive advantage,
5. Information technology based value could be latent,
6. There are numerous factors mediating information technology and value,
7. Causality for information technology value is elusive.

Kohli and Grover's list of themes are based on an existing literature review. According to Kohli and Grover, information technology embeddedness is a central concept, which is used together with a co-creation of value, information mindset, and value expansion. It is worth noting that Kohli and Grover recognized indirect research settings. I emphasize that they do not use the concept of Alter's IT-reliant work system. IT-reliant work system could have enriched evaluation process of the value of information technology. However, Kohli and Grover did not recognize Alter's work. The concept of information technology embeddedness is defined as an integral part of the business process, thus I can argue that the meaning of the concept information technology-reliant work system and the meaning of information technology embeddedness are similar.

The value of an information technology can be identified so that innovations and solutions of information technology offer possibilities to develop information systems, which can be used cost-effectively and to new purposes in work systems. I propose that in order to develop an evaluation method of a virtual learning application, starting from hardware, software, and the network capacity requirements, it is possible to evaluate the IT-value only. However, Kohli and Grover argue the other components that must be included to an evaluation method if the target is to evaluate also IS-value.

I identify an information system as a socio-technical system that includes technical components, data and stakeholders, who use the system. Stakeholder makes a choice on how to use the system, create, develop the system, and maintain the information system. I emphasize that a virtual learning application is a component of a socio-technical information system. When discussing usage of virtual learning systems, I recognize that nowadays some users (hackers) may misuse by mistake or abuse an information system (trackers). I identify a virtual learning application as a technological system with people. If I concentrate on only the technical properties of the virtual learning application, then I can exclude people from the evaluation method, and see as passive users. However, a virtual learning application is a socio-technical information system, and thus stakeholders' role is important.

When I explore an evaluation project as a research object, I can consider different organizational levels, in which evaluation processes can be arranged. Smithson and Hirschheim (1998) recognized five different levels where evaluation can be performed:

1. Macro-level (Multi-national and National),
2. Sector (Manufacturing, Wholesale, Retail, Education),
3. Company or organization,
4. Application and
5. Stakeholder

A macro-level evaluation for a virtual learning application can be organized and the main purpose at the macro level is to explore how many learning organizations are utilizing virtual learning and what are the national objectives of virtual learning. By considering a sector in education, I can argue that evaluation can be organized according to the school-system in a country. A company in education is an organization, and evaluation can be organized at the organizational or unit-level. An evaluation for application can be organized by studying a single application or set of applications. An evaluation at the stakeholder level in the educational organization can be organized by arranging a single evaluation, in which all stakeholders are participating. It can be arranged only for a single stakeholder group, or in a very special situation, only one person can participate in the evaluation. However, I argue that in a real situation, organizational level, applications, stakeholders should be taken into account, when I am planning how to arrange an evaluation project. Smithson and Hirschheim (1998) argue that an information system and, in this case a virtual learning application has social, organizational, human and technological impacts. These impacts should be taken into account when developing evaluation methods. The learning and teaching time schedule can change when a virtual learning application is in use. Managers may calculate costs and benefits in the short and long run.

Berghout and Remenyi (2005) have meta-analyzed evaluation theories and approaches of research papers that have been accepted by the European Conference of IT Evaluation (ECITE) during the past eleven years. They point out that 513 authors have contributed to this research area. When they categorized the evaluation methods, they used as examples Balanced Scorecard, Simulation, and Dynamic System Development Methods (DSDM). Berghout and Remenyi argue that the development has been modest in general. They point out, that most of the theoretical works were published outside of the conference and in book forms. When Berghout and Remenyi consider reasons why evaluation methods have not been published as a conference paper or articles, they recognized that a proper text requires more than 5000 words to describe an evaluation method, and many conference papers have been limited to 5000 words, including ECITE conference papers.

In Table 4.2, I represent evaluation methods by utilizing Berghout and Remenyi's literature review. The represented methods are classified to research method (RM) or meta-method (MM). It is worth noting that in Table 4.2 researchers are listed mainly only in this table, but not in the list of references. I point out that Berghout and Remenyi's literature review is available online. Remenyi et al. (1997) defined the IS-evaluation "a series of activities incorporating understanding, measurement and assessment. It is either a conscious or tacit process, which aims to establish the value of or the contribution made in a particular situation. It can also relate to the determination of the worth of an object." Pries-Heje, Baskerville and Venable (2008) investigated evaluation process and activities identifying two perspectives for evaluation process: ex-ante and ex-post by taking Bannister and Remenyi's (1999) list of ex-ante evaluation methods, which are presented in Table 4.3. It is worth noting that Bannister and Remenyi classified evaluation methods (approaches) without explicitly categorizing ex-ante or ex-post methods, while Pries-Heje, Baskerville and Venable identified ex-ante evaluation methods by utilizing Bannister and Remenyi's classification for ex-ante evaluation methods and ex-post evaluation methods are classified by utilizing Yang and Padmanabhan's (2005) classification. According to Yang and Padmanabhan, information systems can be evaluated by

using an automatic evaluation process and by using experimental data or by using historical data and/or by organizing user opinion evaluation process or by using available data of opinion analysis.

Table 4.2 Evaluation methods based on different theories.

Theory or approach	*Description of methods*	*Researchers*
Economic/Account theory (RM)	Cost-benefit analysis (CBA). Net Present Value (NPV). Return on Investment (ROI). Pay Back Method (PBM). Return on Capital (ROC). Hybrid Discounting (HD).	Dier and Mooney, 1994; Dirks and Lent, 1997; Bannister and McCabe, 1999; Maanen and Berghout, 2001; Svavarsson, 2002.
Interpretive Approach (RM)	Hermeneutical methods of interpretation.	Serafeimidis and Smithson, 1994; McBride and Fidler, 1994; Abu-Samaha, 2000.
Critical Approach (RM)	Critical theory (CT) Socio-technical approach (STA). Social shaping of technology (SST). Actor-network theory (ANT).	Nijland, 2001; O'Donnell and Hendriksen, 2001; Jones and Basden, 2002; Klecun and Cornford, 2005.
Structuration Theory (MM)	Structural differentiation (SD). System-theoretical approach (STA). Action-theoretical approach (ATA)	Vaujany, 2001, Jansen and Nes (2004).
Grounded Theory (RM)	Systematic data collection and analysis (SDCA). Theory building. Multi-Grounded Theory (MGT)	Jones and Hughes, 2001. Cronholm (2003). Cronholm, 2005. Åkerfalk, 2004.
Contingency Approach (MM)		Turk, 2000.
Cognitive Mapping		Newman and Hang, 2002.
Option Theory (MM)		Jong, et al., 1997; Clare and Lichtenstein, 2000; Mehler-Bicher, 2001; Svavarsson, 2002.
Soft System Methodology and Process Theory (RM)		Kefi, 2002; Stansfield et al., 2000.
Social Theory (MM)		Berghout et al., 1996.
Post-Modernism (MM)		Remenyi and Sherwood-Smith, 1996.

It is good to recognize that evaluations in use are seldom organized. Therefore, I argue that used information technology and information system in use should be evaluated. Why information system in evaluation is rare, I assume that one obvious reason is that decision-makers try to very often estimate costs and benefit, but quality of current information technology and information system usability are not so often evaluated.

Table 4.3 Categories of ex-ante evaluation methods (Bannister and Remenyi,1999).

Basic approach for evaluation			
Application	**Fundamental**	**Composite**	**Meta-methods**
Positivist/ Reductionist	Fundamental measures are metrics, which attempt to assign parameters to some characteristic or closely related set of characteristics of the investment to a single measure. Financial methods are typical and commonly used.	Composite methods are combination of several fundamental measures and main aim is to get a 'balanced' picture of value/investment return. Balanced Scorecard is one of the evaluation methods and Weighted scale measurement is the second one, which are applied.	A decision-maker attempt to select the optimum set of measures for a context or set of circumstances. This meta orientation is not usually structured and there is no question of the organisation wishing to use this approach for any sort of benchmarking other than for internal comparison between different projects and or over time when the same meta approach is being applied.
Hermeneutic	Hermeneutic is defined as methods of interpretation of data, which use non-structured approaches to both understanding and decision-making. Various techniques are used to provide a level of visual support to this process: spider charts and cognitive maps being two of the best known.	The decision-maker takes on board several different metrics directly and combines them in his or her mind in a manner that cannot be formally stated.	It is in this area that instinct and intuition plays the biggest role. It is sometimes argued that this is the most important aspect of decision-making.

Next I explore some researches, in which evaluation methods are investigated and classified. Escobar-Peres is selected as an example of how Spanish companies were using evaluation method at 1990s. Irani and Love's (2002) article included a taxonomy of evaluation methods, and it was selected for that reason. Khalifa et al.'s (2003) article was selected for because it includes analysis of roles of stakeholders in the evaluation process, and I will use stakeholders' role, when I try to develop an evaluation method for virtual learning application.

Escobar-Peres (1998) carried out an investigation in Spain on how and what investment appraisal models were used in different industry branches. He found out there were decreasing trends in the use of NPV and IRR, and that explicit business objectives and management decision-making are the most preferred evaluation/selection criteria. Escobar-Peres considered what these motives are for studying investment on different points of view and found out evaluation criteria for information systems can be classified to the following: *1) Financial criteria, 2) Management criteria and 3) Development criteria.*

Irani and Love (2002) present the taxonomy of investment appraisal. Irani and Love classified the possible appraisal (evaluation) techniques from an information system's investment point of view. The original list of evaluation methods includes, the name of each method, each developer, the time, and when that technique was used for the first time. The article is a good reference list, when someone is looking for suitable appraisal (evaluation) techniques for IT investments. Irani and Love offered their taxonomy as a 'frame of reference' in evaluation techniques. The evaluation techniques that Irani and Love identified are presented in Table 4.4. The term appraisal is used as a synonym of evaluation. I argue that Irani and Love's evaluation techniques are mainly useful for a strategic evaluation and to strategic and economical decision-making. Tactical and operative decision-making in those evaluation techniques are not necessary applicable, since economical aspects are not as important as operational functions and usability of information system.

Khalifa et al. (2003) analyzed stakeholders' roles in the evaluation processes, and they argue that users and organizational context are excluded from most IT-evaluation methods. However, stakeholders' roles and participation are recognized in many researches to be important and if excluded, the reason can be failure of information systems development projects, and when the usage of an information system is not accepted or even an information system is rejected. Khalifa et al. point out that if evaluation process is carried out by utilizing cost-benefit evaluation method, then financial goals are taken into account, but not users' opinions. It can be argued that information system users are implicit participants, if members of an evaluator group include at least a single user. Khalifa et al. explored how to find out who are stakeholders and they listed management literature as an example, in which stakeholders' roles are investigated. However, stakeholders' roles are also investigated in information systems and information technology literature. For example, Lyytinen (1988) has investigated stakeholders' role in his exploratory study of failure of information systems. Khalifa et al. emphasized that involvement of stakeholders in development processes has been recognized and interpretative evaluation methods are recommended (Walsham, 1993, Serafeimidis and Smithson, 1998). Khalifa et al. identified primary and secondary groups of stakeholders, and members of primary group are end-users, and members of secondary groups are customers, suppliers and other members of organization that are not using an information system.

In Table 4.4, there are indeed many theories and approaches used evaluation during the past eleven years. Berghout and Remenyi argued "…there is a tendency for many novice researchers to try to reinvent or define basic concepts repeatedly. The notions of value and benefits to mention only two ideas are churned over again and again with virtually no progress to show for this debate. This need for theoretical underpinning is perhaps the most difficult area of IT evaluation research to tackle and one which needs the most philosophical and theory building

attention." (2005, p. 89). A novice researcher faces a very difficult decision problem how to select an appropriate evaluation method.

Table 4.4 Taxonomy of investment evaluation techniques.

Appraisal Technique group	Name of Techniques	Developer
Analytic Portfolio	Weighted Scoring Models Conventional Programming Approaches Artificial Intelligence	Saaty (1980) Galmon (1986) Primrose and Leonard (1986) Irani et al. (2001) Daugherty et al. (1993)
Strategic Appraisal	Technical Importance Competitive Advantage R&D Critical Success Factors	Meredith and Suresh (1986) Naik and Chakravarty (1992) Meredith and Suresh (1986) Irani et al. (1997) Rockart (1979) Williams and Ramaprasad (1996)
Economic Ratio Appraisal	Payback Return on Capital Cost Benefit Analysis	Huang and Sakurai (1990) Primrose (1991) Parker et al. (1988) Lumby (1993) Pavons (1983) Hares and Royle (1994)
Economic Discounting Appraisal	Net Present Value Internal Ratio of Return Hybrid Discounting	Parker et al. (1988) Dugdale (1991) Dugdale (1991) Kakati and Dhar (1991) Pearson (1985) Michael and Millen (1985)
Integrated Appraisal	Multi-attribute/Multi-Criteria Scenario Planning Pricing Models	Parker et al. (1988) Canada and Sullivan (1989) Schoemaker (1995) Garret (1986) Kulatilaka (1984) Na et al. (1995)
Other Analytic Appraisal	Risk Handling Value Analysis	Michael and Millen (1985) Remenyi et al. (2000) Money et al. (1988) Conrath and Sharma (1993)

I point out that the mentioned researchers in Table 4.4 are not included the list of references, unless they referred to elsewhere in this thesis.

When I consider how top management can allocate resources to information technology projects, it is rather common to use economic and financial based evaluation techniques (methods). For example, Escobar-Peres (1998) identified this situation in Spain. "For the financial management and management accounting-functions, the use of different criteria in cost-benefit analysis preceding all IS investment decisions, determines whether or not the project should be undertaken, and therefore, it has a significant impact on the profitability of the firm." as Escobar-Peres considered (1998, p. 203) evaluation analysis in Spain. Escobar-Peres points out that the companies used more than one selection criteria and depending on the total values of information system investment the companies used criteria that supported explicit business objectives and the most often used financial criterion was a discounted cash flow. Even technical criteria are considered as primary criteria in the Information Systems literature, Spanish companies did not use these criteria. The payback methods were used when companies calculated short-term costs and benefits.

Frisk and Planten (2004) carried out a survey research on how managers perceived information technology investment evaluation in Swedish companies. The respondents of survey were IT managers. Frisk and Planten grouped evaluation criteria for information technology investment to the following groups:

a) Strategic match, meaning, how well evaluation criteria for IT investment are derived from company's strategy.
b) Impact on organization,
c) Stakeholders,
d) Risks,
e) Financial aspects, and
f) Costs and benefits

Frisk and Planten (p.145 – 147) grouped their survey questions to the following:

1. What are your company's current goals for IT investments?
2. Is your company successful in achieving business value of IT investments?
3. Is your company successful in evaluating business value of IT investments?
4. What overall method/model does your company use to evaluate IT investments?
5. Which are the most common barriers to achieving business value of IT investments?
6. When do you evaluate IT investment projects?
7. In what way does your company evaluate IT investment projects?
8. What criteria do you consider in the evaluation of IT investment projects?
9. What are the most important criteria to consider in IT investment projects?
10. What are the biggest difficulties of IT investment projects?

Frisk and Planten's results of the survey revealed that companies were successful achieving cost reductions by IT investments. However, researchers consider, how managers perceived that cost reductions are achieved, when the post-implementation evaluation was carried out seldom (only 16% of companies answered that proceeded with the post-implementation evaluation). Frisk and Planten concluded that implication for research based on results of survey that collaboration with practitioners can create understanding of how to develop evaluation method

for IT business value, and how to develop a more applicable evaluation method for IT investments.

Marshall and McKay (2003 p. 2) point out that in many cases the IT evaluation process is not carried out at all or an evaluation is done by using inadequate methods. They argue that one reason may be due to inadequate IT governance and structure, and they stress the necessity to analyze IT investment from two points of view at least, and merge the approaches into a single process. They in Figure 4.5 describe the procedure, where the starting point is the business benefits, and next step is making a decision on the IT investment and carry on the needed business changes, and create clear and visible business objectives and decide what kind of IT investments are needed. IT investment processes continue creating IT investments requirements and evaluation criteria and at the same time start to plan required organizational changes, which should be carried out proactively, and changes should have aligned to IT investment planning processes and initiation stage. Marshall and McKay describe the IT investment process by using five stages: *a) planning b) aligment, c) identifying a benefit d) evaluating IT investment and e) make a choice.*

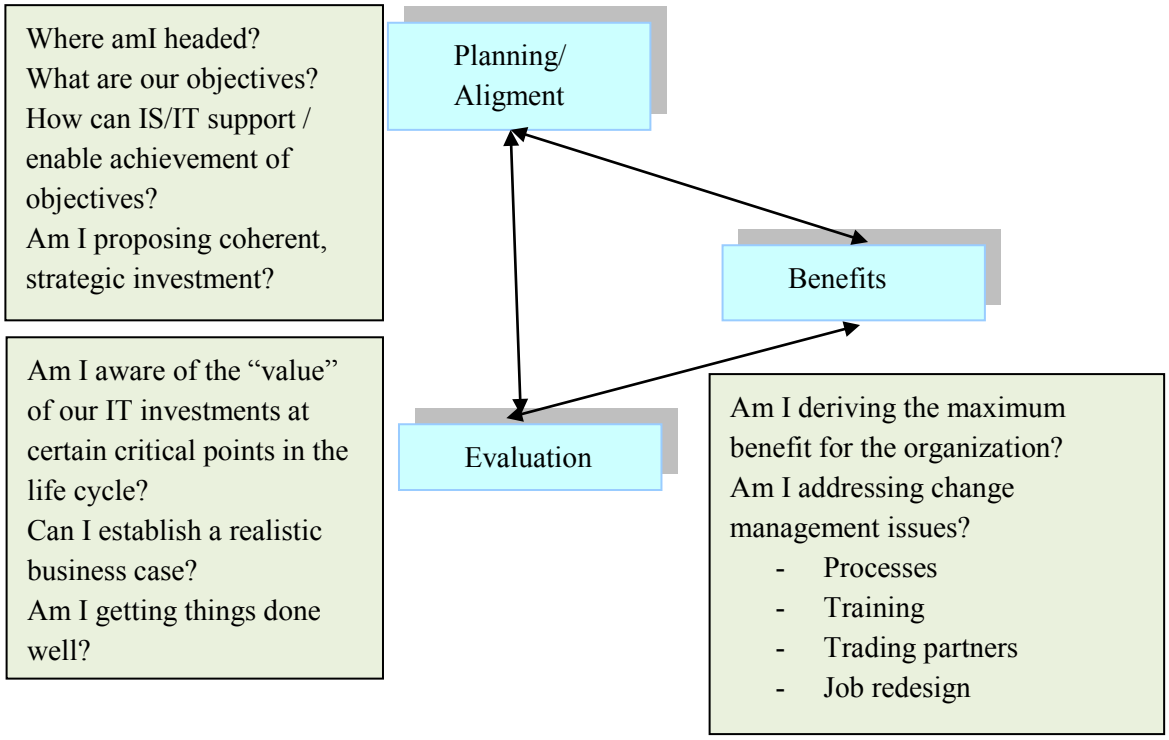

Figure 4.5 The Marshall and McKay Planning and Evaluation value of IT investment approach.

The questions that are included in Figure 4.5 are relevant for strategic discussions. However, tactical and operational questions are not included in the model. I emphasize that during the IT investment planning, I should consider tactical and operational aspects too, otherwise, there is a danger that I may forget some important matter that can affect the future and hinder the installation. Marshall and McKay's research include six business cases in Australia that they analyzed.

1) *The first stage is to build a business case, after presenting the proposal for the needed IT investment. In many cases, the original idea came from Strategic Business Unit (SBU).*
2) *The second stage is alignment and prioritization and during this stage IT investment proposal was analyzed by the steering committee and associated to strategic planning. During the stage of alignment and the prioritization, all large IT investments were analyzed and cost-benefit calculations were carried out and analyzed.*
3) *The evaluation stage follows the prioritization stage; during the evaluation process, the business objectives and the IT investment requirements were analyzed and evaluated. The cost-benefit evaluation method was used.*
4) *The IT system acquisition stage means that the CIO and the Strategic Business Unit managers had to make a choice to build an in-house system, or buy or hire an IT system use some IT system provider (ASP),*
5) *After the acquisition stage of the IT system, it had to be implemented and the started to use.*

Marshall and McKay pointed out that many Chief Information Officers (CIO) argued, that during this stage the resources were small and resources were allocated to other purposes at the same time. Following Marshall and McKay's conference paper proposals, I pay attention to IT investment processes, in which systematic evaluation methods should be used, thus cost-benefit evaluation method and evaluation of requirements should be also analyzed. For the evaluation point of view, I argue that requirements of IT investment can be used for basis of evaluation criteria.

4.5 Commercial off-the-shelf and Open Source software evaluation methods

In this section, I explore how an evaluation method for commercial off-the-shelf products can be utilized in the evaluation process for virtual learning applications. The contemporary Information Systems' literature reviews reveal that evaluation methods for commercial off-the-shelf software exist (Dean and Vidger, 2000; Wanayama and Far, 2008, and Jadhav and Sonar, 2009). The investigated evaluation methods and metrics included features that are suitable for in this study. I point out that besides the commercial off-the-shelf products, Shareware/Freeware should also be identified in the evaluation processes. In many cases, small and medium size organizations are considering open source software as promising products. Public organizations are also interested in open source software, so I think that it is important to investigate an evaluation method for open source products too in the future.

Dean (2001, p. 2) defines commercial off-the-shelf software or product as "a product, which is sold, leased, or licensed to the general public. It is offered by a vendor trying to profit from it. A product is supported and evolved by the vendor, who retains the intellectual property rights. It is available in multiple, identical copies." A similar definition exists Comella-Dorda et al.'s (2004) a COTS product is "sold, leased, or licensed to the general public, offered by a vendor trying to profit from it, supported and evolved by the vendor, who retains the intellectual property rights, available in multiple, identical copies, and used without modification of the internals". It is a general fact, that the commercial off-the-shelf software is used with

modification, and I can argue that is the main purpose, when vendors are developing software based on very general requirements.

Basili and Boehm (2001a, b) proposed the following definition: commercial off-the-shelf software has the following characteristics: the buyer has no access to the source code. The vendor controls its development, and it has a nontrivial installed base (that is, more than one customer, more than a few copies). Basili and Boehm's definition is essentially similar as Dean's definition of the commercial off-the shelf software. Vidger et al. (1996) offer the following definition: commercial off-the-shelf software are products; sold in many copies with minimal changes; whose customers have no control over specification, schedule and evolution; access to the source code as well internal documentation is usually unavailable; complete and correct behaviour specifications are not available. According to Morisio and Torchiano (2002), commercial off-the-shelf software can be divided to a) COTS product, b) COTS-based system, and c) components of COTS software.

Dean (2001) compares Open source and Freeware/Shareware software with commercial off-the-shelf software by stating that Freeware/Shareware software vendors profit is branding recognition, not necessary dollars. Open source software is developed by community c.f. Apache organization, thus open source software is used by accepting its licence agreement. It is the fact that currently many commercial software companies (IBM, Microsoft, Novell, and others) participate in Open source projects by funding or developing software that is offered under the Open source license agreement. Accepting that, small and medium size companies considering a change or buying software, also have to screen open source software alternatives. However, support and necessary modification may have been difficult to find out for some open source software, and that must be taken into account in decision-making.

By following Morisio and Torchiano's classification (2002) for COTS software, I argue that Open source software can be categorized Open Source products, OpenSource based system, and components of Open Source software. It is the fact that Open source software is available for downloading after accepting a suitable license for using Open source software, thus I propose a term 'Open source for downloading software (OSDS) by following a similar style as commercial off-the-shelf software (COTS).

By exploring evaluation and selection methods reviews by Dean and Vigder (2000), Kunda (2002), Wanyama and Far (2008), and Jadhav and Sonar (2009), I am able to produce a summary of different types of evaluation and selection methods, which are proposed for commercial off-the-shelf software evaluation and selection. Dean and Vidger (2000) explored 4 evaluation methods, Kunda (2003) represented 5 evaluation methods, Wanyama and Far (2008), investigated 11 evaluation and selection methods, Jadhav and Sonar's (2009) review includes 10 evaluation methods, in which commercial off-the-shelf evaluation and selection methods are explored. Jadhav and Sonar's main criterion for including a paper in their review was that the paper describes and explores evaluation and selection methods for the software package, thus I consider that packaged software and commercial off-the-shelf software means similar software, so the term packaged software and commercial off-the-shelf software are used as a synonym. In comparison to Wanyama and Far's review paper with Jadhav and Sonar's, I notice that both papers include four evaluation methods that are explored in detail. In Table 4.5, I pay attention

to different evaluation and selection methods, and point out that some of the evaluation methods are developed for software project evaluation.

Table 4.5 Summary of evaluation methods for software

Evaluation and selection method for COTS	Dean and Vidgren (2000)	Kunda (2003)	Wanyama and Far (2008)	Jadhav and Sonar (2009)
Checklist Driven Software Evaluation Method (CDSEM), Jeanrenaud and Romanazzi's (1994)	x			
Software System Evaluation Framework (Boloix and Robillard, 1995)		x		
Off-the-Shelf Option, (OTSO), (Kontio,1995)	x	x	x	x
Delta (Brown and Wallnau, 1996)		x		
Formal Process for evaluation COTS, (Lawlis et al. 1997)				x
Cots-based Integrated System Development (CISD), Tran and Liu's (1997)	x			
Social-Technical Approach for COTS (STACE) Evaluation (Kunda et al. 1999),		x	x	x
A proactive evaluation technique (PET) Dean and Vidger (2000)	x			
COTS Acquisition Process (CAP), (Ochs et al. 2000),			x	
COTS-based Requirements Engineering (CRE), (Alves et al. 2000),			x	
COTS-Aware Requirements Engineering (CARE), (Chung et al. (2002),			x	
Combined Selection of COTS Component (CSCC), (Burgues et al. 2002)			x	
Comparative Evaluation Process (CEP) (Cavanaugh, et al. 2002),			x	
Storyboard (Comella-Dorda et al. 2002),			x	x
Desmet Methodology and AHP, (Morera, 2002)				x
Domain-based selection method, (Leuing, 2002)				x
A process for COTS evaluation, Santiago et al., 2002)				x
Procurement-Oriented Requirement (PORE) Engineering by Ncube et al. 2003),	x	x	x	
Quality of software method for evaluation, (Oh and Lee, 2003)				x
COTS Component Selection (CCS), (Bhuta Boehm ,2005)				x
Framework for COTS Wanyama and Far 2008)			x	

To conclude the evaluation methods review, I emphasize that evaluation and selection problems have been a continuous research object in Information System's researchers in the last decades. By investigating different evaluation and selection methods in Table 4.5, I represent the four reviews, there is Kontio's OTSO method in all reviews, Procurement-oriented requirement (PORE) method, and social-technical methods are in three reviews. In Table 4.4, by exploring it, I can notify that 1994 – 1997 was the first active period, when evaluation and selection methods were proposed, the second active period was 2000 – 2003, and it seems that the third period started 2008. However, the evaluation and selection method was developed before 1994, mainly for IT developing processes of evaluation.

Wanyama and Far (2008, p. 35) identified the following challenges, which are associated with the evaluation and selection problem:

i) Generation of high-level information used for decision-making,
ii) Need for hierarchical decision-making,
iii) Many similar COTS products (evaluation methods),
iv) Multiple COTS selection objectives,
v) Changing COTS features due to updates,
vi) Multiple Stakeholders,
vii) Management of information for the current and previous COTS selection processes, and
viii) Selection of COTS products for the different sub-system

Wanyama et al. (2007) has represented the framework for a commercial off-the-shelf selection method, which was used in the empirical study in 2008. Wanyama and Far's evaluation method was in comparison to the comparative evaluation process selection (CEP) and to the COTS-based requirements' engineering methods. Wanyama and Far point out that these two methods are applied in practice. Very obvious results are that evaluators prefer selection methods, which are easy to use and to apply in the real selection situation. This observation also supported the author's own experience with the selection processes in the past. I recognize Wanyama et al.'s (2007, p. 44-45) comments that commercial off-the-shelf software evaluation and selection method has an association with the real decision-making process, otherwise evaluators can have an impact on the fact that evaluation and selection process is not so important to carry out in the specified time.

Commercial off-the-shelf software acquirement decisions are according to Stamelous and Tsoukias (2003) a difficult problem, thus decision makers have to solve, keep or change a problem, when vendors are offering new or upgraded software. By considering new software or information systems acquirement problem, decision-makers have to solve, make or buy problem. Stamelous and Tsoukias represented the following types of problems:

1. *Keep old software or change it to a new one or upgrade the old software (version),*
2. *Make or buy problem, in which it is considered in-house software projects and alternatives to buy (commercial) or to acquire (open source) off-the-shelf software and be ready for modification and customization costs,*
3. *Organize commercial of-the-shelf product evaluation, (this may include also Open source/FS software evaluation process),*
4. *Organize a tender evaluation process, in which possible tenders are evaluated,*

5. *Carry out software certification process, in which IT company tries to certificate its software processes and products,*
6. *Organize selection process, in which it is evaluated possible software design systems or design tools.*

The first decision problem is a general and regular problem in many private and public organizations, thus decision-makers have to consider if the current software acceptable and fulfils the requirements and are users satisfied. From the decision-makers' point of view the question is when to update software. Software vendors are regularly developing and offering new versions to market and decision-makers have to decide to accept or not accept available versions and how often changes should be carried out. The second problem: make or buy can be a difficult and thorny decision problem, if organization's IT-department is small and there are only one or two software developers, then decision-makers face the problem of whether to make or to buy. The third decision-making problem is an essential design science phenomenon. I think that it is a matter of opinion to keep them as different problems. The fourth problem is emphasized that organization should carry out a software and vendor evaluation processes, in order to keep knowledge of software market updated. The fifth problem is more or less the vendors' problem. From the customer's point of view, certification is one feature of software or if a vendor's development process is certificated. The certification is a promise that development processes are organized according to generally accepted rules. The sixth problem is still nowadays an academic problem, since many research papers identify that practitioners either do not know the evaluation and selection process systems or tools or are not using these.

4.6 Balanced Scorecard evaluation method

The Balanced Scorecard evaluation method developed by Kaplan and Norton (1996) is shortly explored in this study. It was used for an evaluation method for an engineering educational system in Taiwan. The original purpose to develop Balanced Scorecard by Kaplan and Norton was to create a strategic method for analyzing and controlling total business processes. The Balanced Scorecard (BSC) was developed in order to find out a management tool for analyzing and evaluating business processes. However, it has also been used for IT-systems and software evaluation. Ho, Cheng and Lin (2001) presented the BSC based evaluation method that they used when they analyzed an engineering educational system. Ho, Cheng and Lin (2001) analyzed engineering educational systems using the following components described in Figure 4.6. The customer perspective can be translated to the student perspective, internal business perspective such as the teachers and tutors perspectives, and a financial perspective as the management perspective. Ho et al. compared their evaluation method to other ranking models, and proposed a performance evaluation method for the engineering education system. Innovation and learning perspective is defined "Can we continue to improve and create value? This component focuses on the infrastructure that the entity must build and sustain in order to ensure and enhance its ability to satisfy customers' expectations." (Ho et. al. (2001, p. 21).

By exploring Ho et al.'s evaluation method, I recognized the following criteria: the customer perspective includes 14 criteria, the Internal Business perspective includes 11 criteria,

Innovation, learning, and financial perspectives include each six criteria. In the article they point out, that they surveyed several heads of engineering education departments in Taiwan. However, Ho et al. do not present in their article any results of the survey, so the criteria and suggestion cannot be tested or verified.

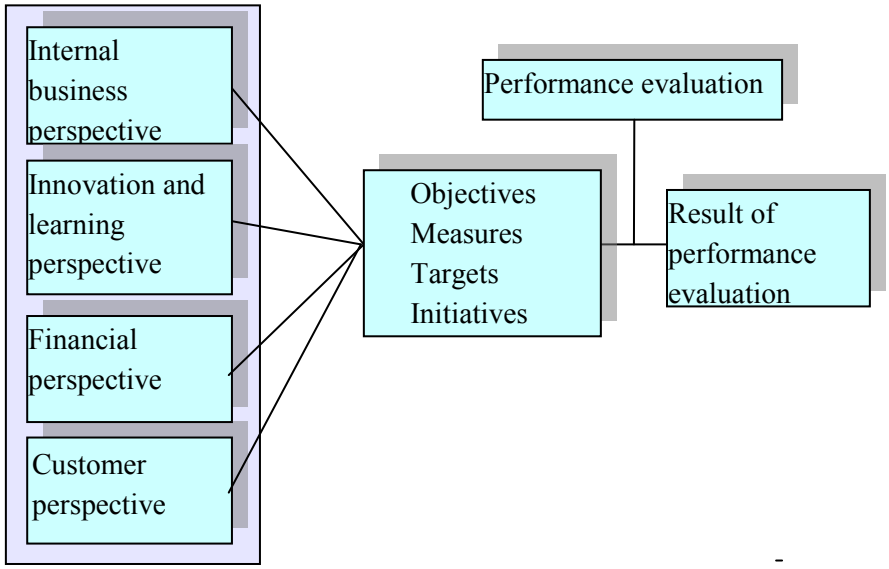

Figure 4.6 The component BSC model of engineering educational system.

Bajaj, Bradley and Cravens (2008) investigated BSC-model and constructed a framework for ex-ante evaluation of the information system. The perspective on their study was firm performance, and to utilize the BSC-method in evaluation. Besides technical properties (data, process, role-process and reports), they combined a business process with information system processes (Alter's work system method) and stressed that information system's properties and business process must be evaluated at the same time. They used business value as an objective and the evaluation output is financially orienting. Therefore, accounting based analysis is included in the system analysis, accounting and strategy (SAAS) framework. Bajaj et al.'s investigation includes critical comments against the net present value (NPV), residual economic value added (EVA) and option analysis (OAM) methods, since cash flow estimates and cost calculation are not always available, which can be used in ex-ante evaluation. However, the recommendation of SAAS framework includes a) System analysis, b) quantitative analyses gathering core data on costs and revenues, and EVA and NPV calculations, c) strategic analyses, in which the BSC-method is utilized. The ex-ante evaluation is carried out by using Likert's item and scale in BSC-method to produce BSC-metrics. I agree with Bajaj et al.'s proposals that ex-ante evaluation includes both information systems and business process analyses.

The method is possible to represent by using the following formulas:

$$\text{Customer perspective} = f(C1+C2+...+C14)$$
$$\text{Internal business perspective} = f(I1+I2+...+I11)$$
$$\text{Innovation and learning perspective} = f(L1+L2+...+L6)$$
$$\text{Financial perspective} = f(F1+F2+...+F6),$$

where C_n, I_n, L_n, F_n are a criteria and n criterion number.

The total method for virtual education evaluation = f (CP + IBP + ILP + FP). The assumption is that the value of the Ho et al.'s formula is positive. Even though it is possible to create formulas for BSC-evaluation and calculate values for each variable, it seems that Ho et al.'s method is too limited for analyzing the virtual learning applications. The summative assumption is a valid property.

Kaplan and Norton (2008) posit the Balanced Scorecard (BSC) method in the right context, when they propose that the BSC is a suitable tool for translating strategy to the objectives and themes that will be used as a base for operative plans. Nørreklit (2003) writes a critical article about the BSC. The main criticism is against the cause-and effect relationship and the BSC- role as a control model (see Nørreklit, 2003, p. 616). This criticism is correct, when it concerns customer loyalty and satisfaction, when there is not any direct measurable variable that can relate to the cause- and -effect relationships. It seems that customer loyalty and satisfaction are multidimensional phenomena. From the managerial point of view, the method does not take competition and technological development into account.

4.7 The updated DeLone and McLean IS success model

The original DeLone and McLean IS success model was identified in 1992, when DeLone and McLean developed their model based on literature review of 100 papers containing information systems evaluation from 1981 – 1987. The second review was carried out in 2003, and according to DeLone and McLean the purpose was to identify how and in which kinds of evaluation situation IS success model was utilized and how the model was used. In the conclusions of the review DeLone and McLean updated the original IS success model combining individual and organizational impact to the one component and named it 'net benefits'. The argumentation is based on the proposals that the following impacts should be added to the model: group impact, inter-organizational impact and industry impact from other researchers. However, they decided to use the term 'net benefits' and claim that to include all proposed impacts will complicate the model, while using the concept 'net benefits' simplify the model. I agree with DeLone and McLean argument. Therefore, now the DeLone and McLean IS success model is usable for all levels of evaluation: individual, group, organization, inter-organization and society.

Petter, DeLone and McLean (2008) updated the IS success model by using a qualitative literature review, analyzing research papers between 1992 -2007 accepting 90 academic papers. The qualitative literature review as a research method was used to reveal how relationships between DeLone and McLean IS success model components were investigated. I argue that results of an analysis at an organizational level are not applicable, the numbers of reviewed articles were only 22, and the number of articles vs. relationships was from 1 to 4, which is not enough to verify or validate relationships and causality. The updated IS success model includes combined component 'Intention to use/Use'.

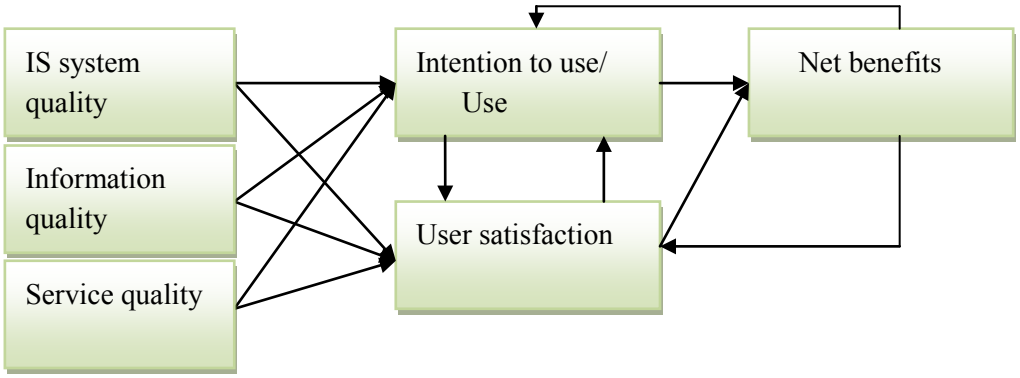

Figure 4.7 the Updated DeLone and McLean IS success model (2003)

Results of qualitative literature review revealed that in the individual level the following relationships are conformed:

Table 4.6 Summary of an individual level of analysis (Petter et al.2008)

Quality	***Intention to use***	***Use***	***User satisfaction***	***Net benefits***
System	N/A	Mixed	Strong	Moderate
Information	N/A	Mixed	Strong	Moderate
Service	N/A	Insufficient	Mixed	Moderate
Use	N/A		Moderate	Moderate
User satisfaction	N/A	Moderate		Strong
Net benefits	N/A	Moderate	Strong	

The component 'Intention to use/Use', includes two different parts, the first part of component is adopted from Davis' TAM-model (1985, 1989) and Davis et al. (1989) and Use is from original IS success model. I point out that 'Intention to use' denotes an attitude not behaviour, whilst the second part 'use' denotes behaviour. I do not agree with Petter, DeLone and McLean's proposals that measuring the direct relationship between system quality and net benefits is correct. Therefore, good or excellent system quality cannot be directly produce net benefits without investigating the real usage of the system. The term 'net benefits' is not an understandable concept, since it includes implicitly: (revenue - cost = net benefits; positive effectiveness – negative effectiveness = net benefits; positive performance – negative performance = net benefits), which are not identified explicitly in updated IS success model, even Petter et al. proposed that the relationship between system quality and net benefits exist. I argue that net benefits can be achieved by using an information system together with the work system as Alter (1999, 2002, 2003a/ b, 2004) stresses that the IS success model alone does not reveal work systems properties and participants' preferences. Therefore, he proposes that the work system and information system should be evaluated together. I point out that it is not verified or validated relationship between service quality and net benefits. However, in a real-life evaluation situation, we need an evaluation criterion, which implicate service quality in an evaluation method for a virtual learning application.

I recognize that Sedera et al. (2004) developed a multi-dimensional measurement for enterprise systems, and I identify the following instrument for to use in our evaluation method: e*ase of use, ease of learning, system features, system accuracy, flexibility, sophistication, integration and customization* as a source of evaluation criteria of evaluation method for a virtual learning application. By integrating the collaborative problem based learning and ideal virtual learning applications, I follow the idea of Alter (1999, p. 47), since he proposed that the learning (work) system and information system overlap at least to some degree, which complicates evaluation processes. However, I try to investigate a virtual learning system as a collaborative problem based learning, which offers the way to identify evaluation criteria, which are based on the specified learning method. Figure 4.10 represents the combination of a virtual learning system and a virtual learning application. A virtual learning environment and its other components are not included in this figure.

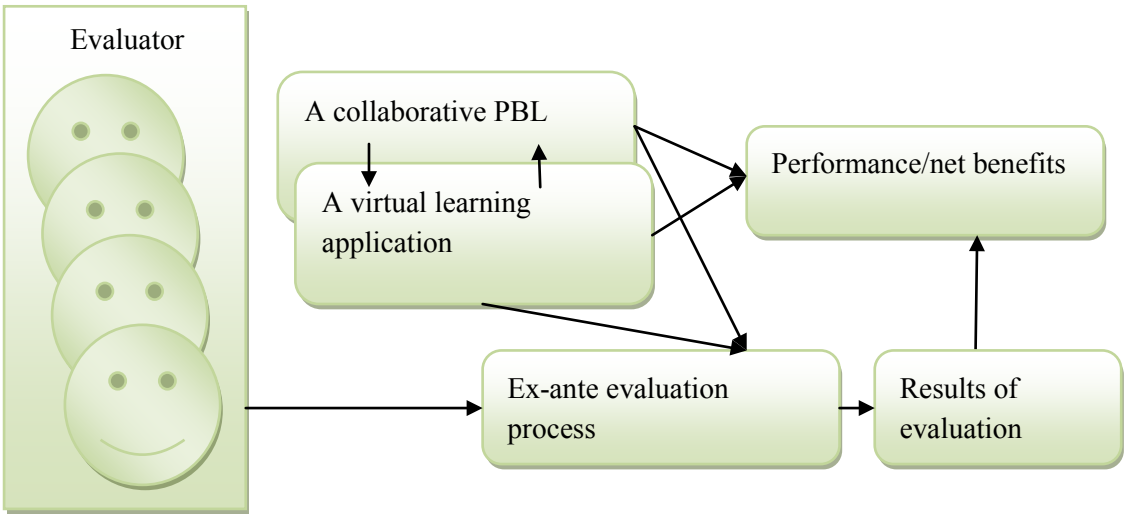

Figure 4.8 A process model of a collaborative PBL learning system and a virtual learning application

Figure 4.8 is developed by using Alter's (1999) work system concept, which is combined with DeLone and McLean's IS success model. Even if it is possible to explore and evaluate the information application independently, without a work system in which it can be used, the evaluation for a virtual learning application can be difficult to carry out, thus in Figure 4.8 it is combined with a learning method. In Figure 4.8, I try to show how evaluators, a learning method, virtual learning application and its performance/net benefit can be integrated in an ex-ante evaluation process model. This process model is from updated McLean and DeLone's information success model. Properties of information system's quality as it is defined in McLean and DeLone's model is represented features of a collaborative problem based learning method and features of a virtual learning application.

4.8 Multi-attribute decision-making metrics

Multi-attribute decision-making models (MADM) are based on utility functions that are developed in Economics and Management Sciences. The basic assumptions can be derived from the decision-makers' goal that the selected application can produce utility and fulfil at least some or all objectives. Multi-attribute decision-making models are based on the research of Keeney and Raiffa (1976) and von Neumann and Morgenstern's (1944) utility theory under the uncertainty (see Fishburn 1977). A decision maker can make a choice if more than one alternative exists and the expected utility can be based on a set of criteria that will be expressed as a utility function U(A) = f(p, O), where p is the probability of the outcome O and A denotes an alternative. A decision maker may select the alternative (A_j), if the utility function $U(A_j) > U(A_k)$, where a utility function $U(A_j)$ is utility function for alternative j and utility function $U(A_k)$ represents utility of alternative k. It is assumed that the expected utility is not known before and therefore, the situation in the future will affect the real value of the utility. The multi-attribute decision making model is presented in a matrix format.

The decision matrices can be presented as a two dimensions, where the first dimension is criteria and the second dimension is alternatives. A criterion is named as C and alternatives are A and B. The weight values are defined so that the sum of the weight values is one. A criterion is rated by using arbitrary value and the rating values are summarized. The score value is calculated by multiplying weight value and rate value. Table 4.6 is an example, how it is possible to create a multi-attribute decision matrix. Matrices can be used for developing a recommendation of alternatives for decision-making.

Table 4.7 The Structure of multi-attribute decision matrix

Criteria	***Weight***	***Alternatives***			
		A		B	
		Rating	Score	Rating	Score
Criterion C1	0,4	5	2,0	5	2,0
Criterion C2	0,3	4	1,2	6	1,8
Criterion C3	0,3	3	0,9	2	0,6
Total	1,0	12	4,1	13	4,4

It is important to recognize that the decisions are made by using ratio score values. The rating scale can be selected from among the ratio scales that may be (0 - 5, 0 – 10, or 0 – 100). In a real life situation, a decision maker must integrate different types of scales (euro, tons, hours), when trying to develop analytic multi-attribute decision models. It can be argued that it is not meaningful to use mixed scales. Therefore, we need a consistent and logical decision model and ratio scales for the criteria that will be included in the decision-making model. Saaty (2006, p. 5) states that multi-attribute decision-making is a process that can be described by using the following steps:

1. *Structure a problem as a hierarchy or a system with dependence loops.*
2. *Elicit judgements that reflect ideas, feelings, or emotions.*
3. *Represent those judgements with meaningful numbers.*
4. *Use these numbers to calculate the priorities of the elements of hierarchy.*
5. *Synthesize these results to determine an overall outcome.*
6. *Analyze the sensitivity to changes in judgment.*

A method that satisfies the consistent measurement scale is that developed by Saaty and first published in 1980. The AHP method is based on the pair-wise technique, since the evaluator compares two alternatives at a time by using the relative ratio scale. For example, Kinosha (2005) offers reasons to use the AHP-method for evaluating complex decision-making problems. The AHP method binds the selected elements (criteria and alternatives) structurally to each other, and I agree with Saaty's definition on the structural dependence between elements. Saaty (2006, p. 22) points out that according to cognitive psychologists people are able to use two types of comparison absolute and relative. According to Saaty (2006, p. 47) I can state a multi-attribute decision making problem by saying that:
"The task of evaluators is to provide judgement on the relative importance of alternatives in question. Evaluators have to conform to the judgements that are quantified to an extent that permits a quantitative interpretation of the judgement among all alternatives."

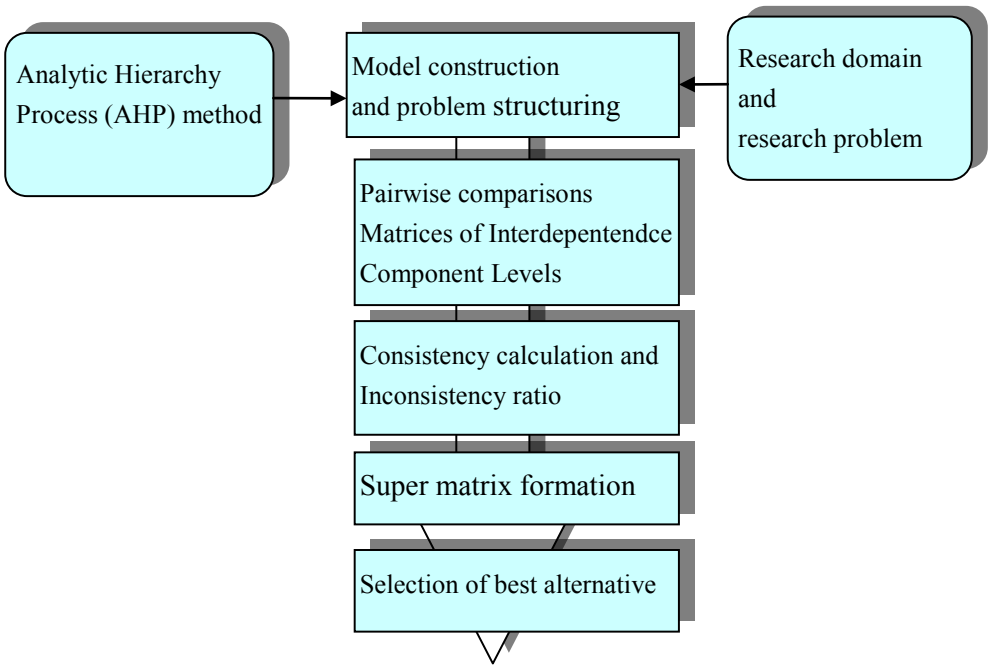

Figure 4.9 The Analytic Hierarchy Process Model

The Analytic hierarchy process method is represented in Figure 4.9. The AHP-method includes the following steps:

1. Model construction and problems structuring, in which the research domain is explored and the research (evaluation) problem is identified,
2. Pairwise comparisons are organized in a matrix format by using, for example, a spreadsheet application (Excel),
3. A consistency calculation and inconsistency ratio are carried out to check that the pairwise calculation and interdependencies are at the accepted value range.

4. Supermatrix formation step includes a process in which rank values for the selected alternatives are calculated.
5. The final step includes a selection process, in which the best alternative is selected (for the evaluator's point of view, step means that suggestions and proposals are represented to decision-makers.)

AHP-method is based on the original three axioms identified by Saaty (1999) and Saaty and Vargas (2001a, b) and the fourth axiom was added after criticism:

"*Axiom 1: The decision-maker can provide paired comparisons aij of two alternatives i and j corresponding to a criterion/sub-criterion on a ratio scale which is reciprocal, i.e.* $a_{ji} = 1/a_{ij}$.
Axiom 2: The decision-maker never judges one alternative infinitely better than another corresponding to a criterion, i.e. $a_{ij} \neq \infty$.
Axiom 3: The decision problem can be formulated as a hierarchy.
Axiom 4: All criteria/sub-criteria, which have some impact on the given problem, and all the relevant alternatives, are represented in the hierarchy in one go."

The evaluation scale of selection criterion is from one to nine and the values are defined conceptually. Table 4.8 includes a definition of the AHP's fundamental scale.

Table 4.8 The fundamental scale of AHP (Saaty 2006)

Intensity of Importance	***Definition***	***Explanation***
1	Equal importance	Two activities contribute equally to the objective
2	Weak	
3	Moderate importance	Experience and judgement slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then has the reciprocal value when compared with i.	A reasonable assumption
Rational	Ratios arising from the scale	If consistence were to be forced by obtaining n numerical values to span the matrix

Values 2, 4, 6, and 8 are so called middle-values that are possible to use, but are not necessary for all evaluators to use during the evaluation process. It is argued that by using the values 1, 3, 5, 7, and 9, the evaluator can more effectively make a decision on how to compare two virtual learning applications against criteria and decide which one gets a better value, when comparing two alternatives at a time.

Pairwise values in matrix A = a_{ij} are calculated by arranging criteria in the following order matrix A = a_{ij}, in which the first criterion is on the first raw and the second is on the second row, and the last criterion is on the bottom roaw of the matrix.

$$\text{Matrix A} = \begin{vmatrix} 1 & a_{1n} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \dots & \dots & 1 & \dots \\ a_{n1} & & a_{nn-1} & 1 \end{vmatrix}$$

Calculating the A matrix means that an evaluator has to only do the upper part of matrix. Pair-wise values can be presented by using a priority vector. The selection is made choosing by $A_w = \lambda_{max}w$. Kreyszig (1993, p. 386 – 389) defines "Ax = λx, where ≠ 0 that value of λ is an eigenvalue or characteristic value of matrix A and a set of eigenvalues is called spectrum of A. The largest of the absolute values of the eigenvalues of A is called the spectral radius of A." Saaty (2006) defines that a pair-wise comparison presented in matrix A leads to condition Aw = λ_{max} or (A-λ_{max}I)w = 0. In order to calculate the eigenvalue, Saaty (2006, p. 78) sets the theorem 3.1 "*If A > 0, w_1 is its principal eigenvector corresponding to the maximum eigenvalue λ_1, $\lambda_i \neq \lambda_j$ for all i and j, and w_i is the right eigenvector corresponding to λ_i then lim $A^k e / e^T A^k e = cw_1$, where c is some constant." and* k->∞.

The principal eigenvector can be calculated by using a powering matrix and row sums are normalized. The calculation can be carried out, for example by using an Excel matrix calculation formula. A company called 'Expertchoice' (2008) arranges other techniques and applications available on its web sites.

In order to calculate $\lambda_{max} = \sum_{j=1}^{n} a_{ij}w_j/w_i$, when we define that Aw = λ_{max}w

and we are able to get an estimate of λ_{max} calculating by $\sum_{j=1}^{n} a_{ij}w_j = \lambda_{max}w_i$, and

after summarizing i and j I obtain $\sum_{i=1}^{n} \lambda_{max}w_i = \lambda_{max}$

The most important value that is used to define the consistency of pair-wise comparison is the consistency index (C.I.) = (λ_{max} –n)/(n-1). Saaty stresses that in reality we can tolerate 10% inconsistency, when calculating consistency indexes in our evaluation matrixes. The suggestion for this inconsistency is based on the random consistency index an (R.I) that is produced by using random numbers of 1/9, 1/8,.., and 1,…,9 and getting R.I. = 1.98(n-2)/n, where n is the number of elements (rows) in the matrix.

Table 4.9 The random consistency index (Saaty 2006)

N	1	2	3	4	5	6	7	8	9
R.I.	0	0	0,52	0,89	1,11	1,25	1,35	1,40	1,45

The term benefit in the above formula can be translated here to denote a preference of a virtual learning application or a property of a virtual learning application. Saaty (1999) argues that the Analytic Network Process (ANP) method is based on the theory of relative measurement argues Saaty (1999) when he gives a brief look at the foundation of ANP. The origin of the ANP model is Analytic Hierarchy Process (AHP) that Saaty developed and published for the first time in 1976. The founder of AHP says that ANP is a general model and that AHP is a special case of ANP.

Set an alternative matrix A = (a_{ij}), where i,j = 1,2, …, n) and assign numerical weights w_1, w_2, …, w_n so that these reflect the recorded judgements. The alternative matrix A is consistent if $a_{ij}a_{jk} = a_{ik}$, where i,j,k = 1,2, …, n and $a_{ij} > 1$ and $a_{ji} > 1$.

The weight value matrix W can be set so that

the weight value matrix W = $\begin{vmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ \dots & \dots & \dots & \dots \\ w_n/w_1 & W_n/w_2 & \dots & w_n/w_n \end{vmatrix}$

where w_1 and w_2 belongs to the ratio scale and the relative value w_1 / w_2 is independent of the unit used, then I can interpret the ratio as an absolute number.

By using the relative ratio scale, I do not need to mix different types of scales. Saaty (2006, p. 49) sets theorem 2.1 with "A positive n by n matrix has the ratio form A = (w_i/w_j), i,j = 1,2, … ,n, if, and only if it is consistent." The second theorem 2.2 states that "The matrix of ratios A = (wi/wj) is consistent if, and only, if n is its principal eigenvalue and A_w = nw. Further, w > 0 is unique to within a multiplicative constant." In linear algebra an eigenvalue is defined according to Friedberg et al. (2003, p. 248) "Let A . Then a scalar λ is an eigenvalue of A if *and only if det(A-λI_n) = 0."* I do not prove these theorems, since valid proof can be found for example Saaty (2006), Friedberg et al. (2003) and Kreyszig (1993). Saaty points out that in real life situation a decision maker cannot estimate absolute values, but only an approximation of the underlining real values of the criteria or properties. With this situation in mind, Saaty (2006) sets four conditions for good approximations. *a) Reciprocity, b) Homogeneity, c) Near consistency and d) Uniform continuity.*

The first condition, reciprocity, follows the local relation between elements a_{ij} and a_{ji}: $a_{ji} = 1/a_{ij}$ and this is a necessary condition for reciprocity. The second condition homogeneity states that local element a_{ij} is uniformly bounded. It can be presented by using the following condition: 1/K $a_{ij} \leq K$, K > 0, i,j = 1,2, …, n. The third condition is global and that is defined by using the coefficient $\lambda_{max} = n$, where n is the number of elements in n by n matrix A. According to Saaty (2006) "*A is consistent, if and only if, $\lambda_{max} = n$*." The fourth condition states that small

value changes of the element a_{ij} is not relatively sensitive and order of the value w_i/w_j remains good approximation according to Saaty. I accept Saaty's (2006, p. 62) theorem 2.11 "*If a positive n by n matrix A is: reciprocal, homogenous, and near consistent, then the scale w derived from* $Aw = \lambda_{max}w$ *is order preserving, unique to within a similarity transformation and uniformly continuous in the* a_{ij}, $i,j = 1,2, \ldots, n$."

The evaluators evaluate an alternative solution by pair-wise appraisal technology giving each selection criterion a numerical value from one (1) to nine (9), then each set of selection criteria is weighted by a relative weight coefficient. The following step in the AHP model is to calculate the eigenvalue vector and super-matrix, which is calculated by multiplying a criteria matrix by itself (c.f. Microsoft Excel includes matrix function, which can be used to carry out needed super-matrix calculations). A decision maker can select an alternative that gets the best priority value according to Saaty (1999) and Salo & Hämäläinen (1997). A general hierarchical structure of AHP model is represented in Figure 4.10, and it is developed by using Saaty's description (2006, p. 95). The purpose to represent a general hierarchical structure is to show that it can be described by using three levels of structure, where a goal is at the first level, the second level includes criteria and the third level represents alternatives.

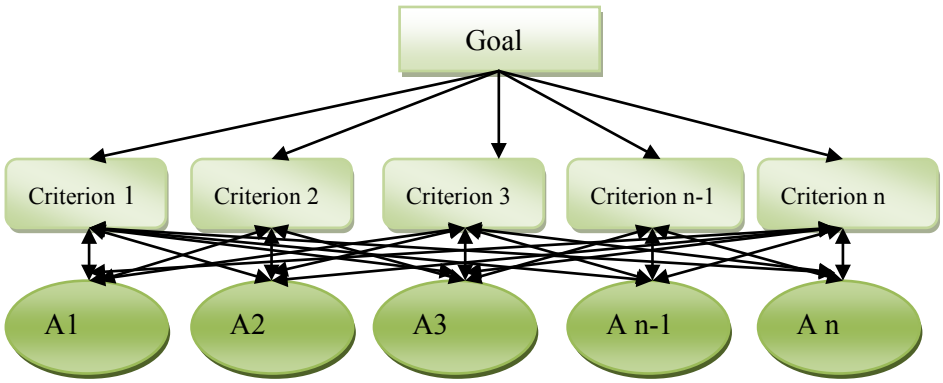

Figure 4.10 Three level hierarchy of AHP method

By developing an evaluation method for virtual learning application using Saaty's suggestion, I define our first goal: how to select a virtual learning application that fulfils stakeholders' requirements and that the selected virtual learning application includes the properties that are essential for a collaborative problem based learning method used in teaching and learning. The second step is to develop criteria based on CPBLM and stakeholders' requirements from the criteria level as described in Figure 4.11. Thirdly, I select the virtual learning applications that will be evaluated. The described analytic hierarchy process method for a virtual learning application includes four levels, since I use a stakeholder' groups and different evaluation criteria for each group.

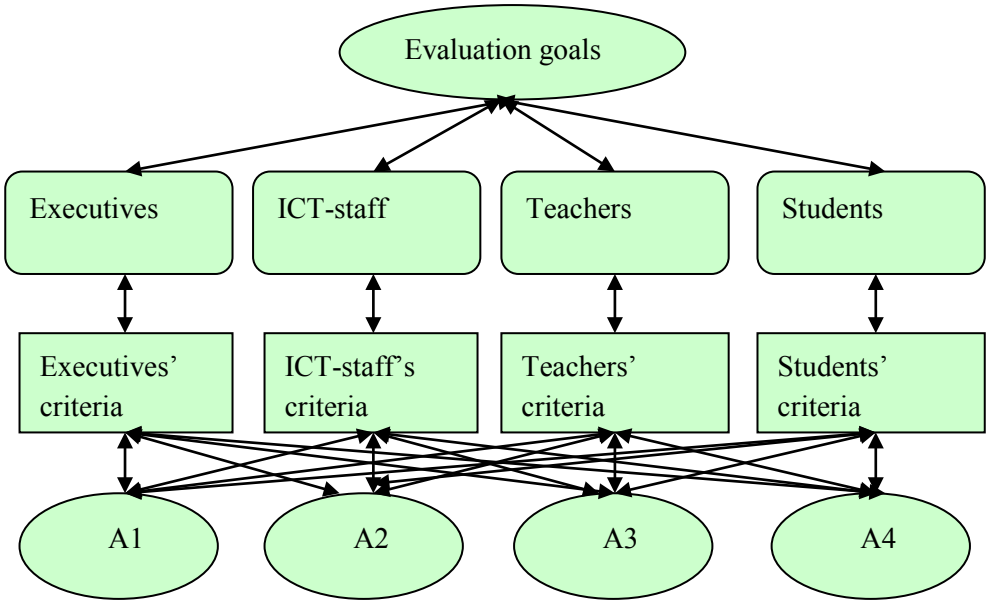

Figure 4.11 The analytic hierarchy process method for a virtual learning application

The arrows in Figure 4.11 show the relationships between goal, stakeholders, criteria of stakeholders, and the selected alternatives. By using AHP-method, I can calculate importance of criterion in each stakeholder, and between stakeholders, by producing ratio scale values.

The AHP model has been used, and tested by many researchers and different research domains. There are also investment analysis tools on the market, based on Saaty's theoretical works, that an evaluator can use during the evaluating process e.g. HIBRE, Web-Hibre, Expert Choice and many others. Mustajoki and Hämäläinen (1999, 2000, 2005, 2006), Mustajoki et al. (2004, 2006, 2007) have used HIBRE+ and Web-Hibre models for analyzing different types of decision situations. The Web-Hibre model is available via the Internet. Laininen and Hämäläinen (2003) analyzed the original AHP model statistically using the robust regression model and the logarithmic the least square regression model.

Salo and Hämäläinen (1997) studied the AHP method and they argue that the model can be presented by the following formula:

$$AHP = w(x) = \sum_{i=1}^{n} w_i / w_j(x)$$

A comparison application criteria$_1$ and application criteria$_2$ is calculated as follows:

$$w_1/w_2 = r\,(1+\sum_{j=1}^{n} w_1 j \,/\, w_1 k) \,/ (\sum_{j \neq k}^{n} w_2 j \,/\, w_2 l).$$

Salo and Hämäläinen argue that the evaluation scale from one (1) to nine (9) can be in certain situations problematic and that is why a decision maker should know what kinds of scale, she or he is using when developing an evaluation method and metrics. They propose that a balanced scale should be used. Salo and Hämäläinen point out that their framework is general,

so there are other models that can be used: MAUDM, MAUT, SMART and SMARTER as they called these. These models are based on Java technology (Java Applets), so the model is usable via the Internet. The models SMART, SWING and SMARTER offer an AHP method for entering the value for each criterion. By using the SMART method an evaluator has to use 1- 10 points; or by using the SWING method (technique) an evaluator can use 10-100 points; or by using the AHP-method then an evaluator carries out pair-wise processes by giving the original AHP evaluation scale from 1,3,5,7,9). When an evaluator uses the Web-Hibre model, it calculates results and these are presented in the graphical or in numerical forms. When discussing the consistency ratio, Salo and Hämäläinen stress that if an evaluator uses another method and scales, then the consistency ratio has to be calculated by using the consistency measure (CM) that is presented as:

$$CM = 2/(n(n-1)\Sigma(\underline{r}(i,j) - r(i,j))/(1-\underline{r}(i,j)(1+r(i,j)),$$

where $\underline{r}(i,j)$ is max $a(i,k)a(k,j)$, $k \in \{1,\ldots,n\}$ and $a(i,j)$ matrix element and $\underline{r}(j,i)$ is the inverse of $r(i,j)$. The reason for using the CM value is such that the original consistency ratio is the only one usable, when an evaluator uses the AHP-method according to Mustajoki and Hämäläinen.

Meade (1997) gives a long list of research where the AHP model is used. She also makes a list of enhancement to the AHP (1997 pp.81-82). A model of the Analytic Network Process Model (ANP), for evaluating e-commerce solutions and platforms is presented and analyzed. She uses ANP with the Balanced Scorecard (BSC) and pair-wise comparisons can be achieved by using different kinds of selection criteria. Meade (1997) studied business processes in her dissertation by using the Analytic Network Process (ANP) and she tested the model by using three case studies. Colace, De Santo and Pietrosanto (2006 p. 1) argue, "A common approach is the introduction of some evaluation grids able to evaluate the various aspects of an E-Learning platform. The weak point of this approach is in the subjectiveness of the judgments. The starting point of the proposed model is the formulation of a multiple criteria decision problem to be solved by the Analytic Hierarchy Process (AHP)." They describe e-learning by using three different components:

a) Learning Management System (LMS),
b) Learning Content Management System (LCMS), and
c) Set of Tools (SoT).

Colace et al. (2006) identified five main features, which were used at the second level in the evaluation method. These main features are the following: *Management, collaborative approach, management and enjoyment of interactive learning, usability and adaptation of learning path.* They recognized that the main features include some sub-features, which should be taken into account, when the evaluation method for an e-learning platform is considered. The selected four E-learning platforms for evaluation were 'Docent', 'IWT', 'Achab' and 'Running Platform'. Colace et al. arranged the identified features according to importance of each main group, which was valued, based on the feature that was needed on a specified course, and they used evaluation grids to set value of every feature. The indexes were calculated by using the obtained value of the feature and divided this value Max value (Max value denotes the value, which is achieved, when all features exist). Colace et al. develop the following index:

a) Management Index = Obtained value of VLE/Max value,
b) Collaborative Index = Obtained Value of VLE/Max value,
c) Management and Enjoyment of Interactive Index = Obtained Value/Max value,
d) Adaptation of users formative learning path index = Obtained Value/Max Value, and
e) Platform's Final Core = $\sum(Weight_i * Platform's\ Value_i)$.

Colace et al. (2006) tested their evaluation method for four virtual learning applications and used three scenarios. Colace et al. used the following courses: *The ECDL course,* a *blended learning university course and a professional training course.* Colace et al. argued that the outcomes of evaluation methods are promising, even for such a small number of suppliers and scenarios. I emphasize that Colace et al.'s indexes are not defined in a way that it is possible to carry out calculation, since the exact Max value is missing it is only identified in the formula. In order to consider, if the AHP method was used correctly, I should have enough information on how values are calculated.

By comparing our AHP-model (in Figure 4.11) to Kontio's OTSO-method (1995), I point out that OTSO-model has arranged the following criteria categories: *a) Functional, b) Quality, c) Domain architecture and d) Strategic criteria.* The evaluation goals and constraints are identified in the goal-box in the OTSO-method. Our AHP-method contains the stakeholders' level, which is not explicitly identified in the OTSO-method. I emphasize that the OTSO-method was used for a single information application evaluation, whereas our evaluation method includes evaluation for selected numbers of applications.

By evaluating strategic information technology/information system investments, Hallikainen and Chen (2006) wrote that the investment process is difficult and controversial to manage and evaluate. They used a (reduced) modified AHP model to appraise a case study of an IT investment process.

A competitive hierarchy structure of AHP identified by Johansson (2005) and Johansson and Johnson (2005a, b, c) describes and analyzes multi-attribute ranking problems. The model is an architecture theory diagram (ATD) and Johansson and Johnson propose that an executive information security system can be best described by using the ATD. By comparing the ATD model with the AHP, I argue that the structure is very similar to AHP, however, Johansson and Johnson start the structure at the property of the top level and by splitting the property into sub-components at level 2 and continue to level 3 and level 4. Questions (criteria) are defined at the fourth level. I point out that the ATD model can be used for structuring evaluation problems, but since the structure of ATD is similar as the Analytic Hierarchy Process, I prefer to use AHP in our study. The ATD model seems to fit rather well to the analysis of the executive information security system, but I am not sure, if the model is applicable to other systems. Considering, what an added value ATD can produce, I do not see at this point how I can utilize the ATD model in comparison with AHP method.

By combining the Lexicographic Ordering (LO)-method and AHP-method, Wohlin and Amschler Andrews (2003a/ b) analyzed the factors for the information system projects. The main objective was to find out factors that can predict success or failure of IT projects. Their

success factor model is based on two types of variables, and the first set of variables consists of project variables (pv) and the second set of variables comprises success variables (sv). The requirement for the variables is that they are ranked in order of type. Wohlin and Amschler Andrews research objective is to identify which project variables are good aggregate for success variables. The measurement is possible to carry out when projects are finished. The project variables are defined before the project start and variables are measured during the project process. Wohlin and Amschler Andrews used the following method in their research, which are represented in Figure 4.12.

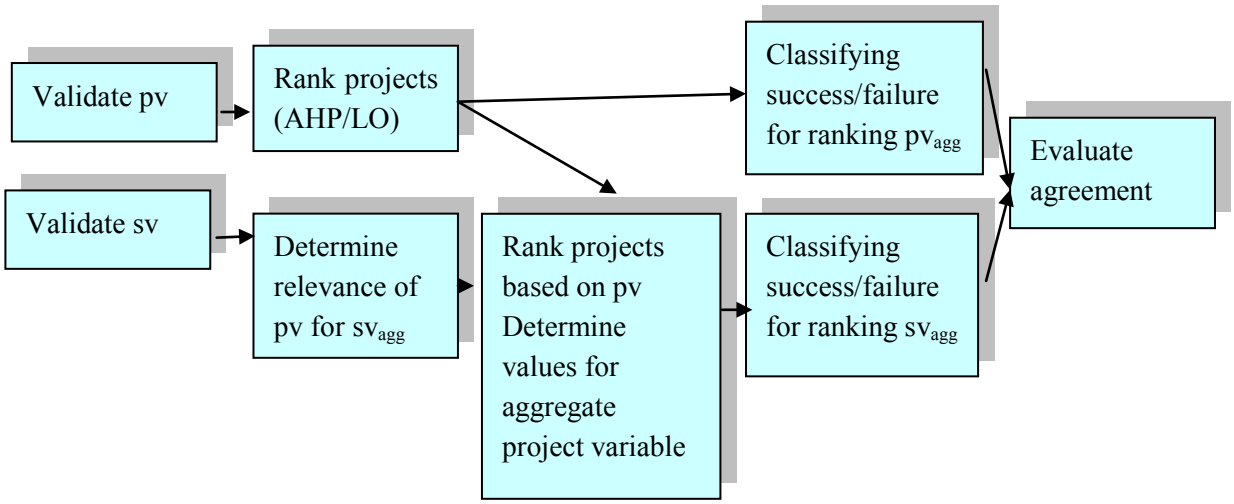

Figure 4.12 Wohlin and Amschler Andrews Method (lightly modified) (WAAM).

WAAM in Figure 4.14 includes seven steps and these steps are described in their research. The first step is to validate both variable groups and give them a subjective nature. The second step is to set a rank value for each project, considering and using success variables. The rank values are calculated using AHP or LO method. The third step is to reduce the number of project variables by determining the relevance of project and success variables. The fourth step that includes the statistical method, the Principal Component Analysis (PCA), which is used to set rank values for project variable and to aggregate project variables. The fifth step includes a process to define which variables best measures success and witch project variables may show failure of the project. The sixth includes a process to determine success/failure of success variables. The seventh step includes evaluation of projects and project agreements. Wohlin and Amschler Andrews argued that both AHP and LO give similar results because the Spearman correlation was 0,995. However, they point out that this may not be true in all cases. When continuing their analysis, they used the AHP method to calculate variable weight values.

In comparison to Wohlin and Amschler Andrews' model with Johansson and Johnson's ATD model, I point out that WAAM model is used for evaluation software projects, while ATD-model is used to evaluate enterprise security systems, how to select an acceptable security level to follow in the future. Wohlin et al.'s model is a tool for analyzing projects, when the objective of an evaluation process is to analyze properties of projects. Wohlin et al. model includes LO technique, which could be used for developing evaluation criteria. WAAM is described in this study, since it includes factors that are possible to use, when trying to find out why evaluation methods are not used in practice. I argue that Johansson and Johnson's ATD model is a modification of the AHP-model and method, since it includes similar hierarchy as in

the AHP-model. I prefer to use AHP-method, since it is generally accepted, and it is used for different types of evaluation processes.

4.8 Summary

Mumford's ETHICS-method identifies objective setting, adaptation, integration, stabilization stages and a final stage demolition is added to the method that ex-post evaluation can be included in the evaluation process. The original ETHICS-method does not mention the demolition stage explicitly. Stakeholders are included in the method and named as a group or individual member. Mumford identifies two groups that also exist in the evaluation process, *a steering committee* and *evaluation group* (design group). I will point out that in the evaluation process in question in this study, there are more than two participating groups, namely *executives, IT-staff, teachers and students*.

Commercial off-the-shelf software evaluation and selection methods was explored and the purpose for this representation was to show that during the last decades, researchers of Information Systems community have investigated and explored a number of evaluation methods and demonstrated methods, how these can be used and applied in decision-making processes. Many of the evaluation methods have been suggested for ex-ante evaluation situations. Vendors are offering virtual learning applications as package software, thus I believe that evaluation methods for commercial off-the-shelf software are plausible methods for virtual learning applications too.

Updated DeLone and McLean's IS success model is analysed, since it is generally used for evaluation for information systems. I use DeLone and McLean IS success model by identifying a single application, not a virtual learning environment. I argue that by evaluating a single application, I am able to develop an evaluation method that offers a way to develop evaluation proposals, which are usable for decision-making. A virtual learning system is described by using Alter' work system.

The conceptual virtual learning environment and evaluation process is described in Figure 4.13. Evaluators are in this figure identified as an observer, a member of executive group, a member of ICT-staff group, a member of teacher group and a member of student group. A virtual learning environment includes a collaborative problem based learning method, an ideal virtual learning application, which is used as a tool for transfer knowledge, other systems and applications. Learning objectives are strategic, tactical and operative, therefore, that I identify a learning organization by using three organizational levels. The evaluation process includes an evaluation method and AHP-method (metrics), which are used for evaluating virtual learning performance of a virtual learning environment. The concept 'performance' is used, since ex-ante evaluation this is the phenomenon, which should be evaluated. However, the concept 'effectiveness' may be used too, anyhow, I prefer use 'performance'.

The roles of evaluators can be explored by setting some assumptions; the first evaluators can be outsiders according to positivist assumptions, the second evaluators are active participants in evaluation and selection process according to action research assumptions, and the third

evaluators are acting as interpretive evaluators according to Lagsten and Goldkuhl's (2008) assumptions.

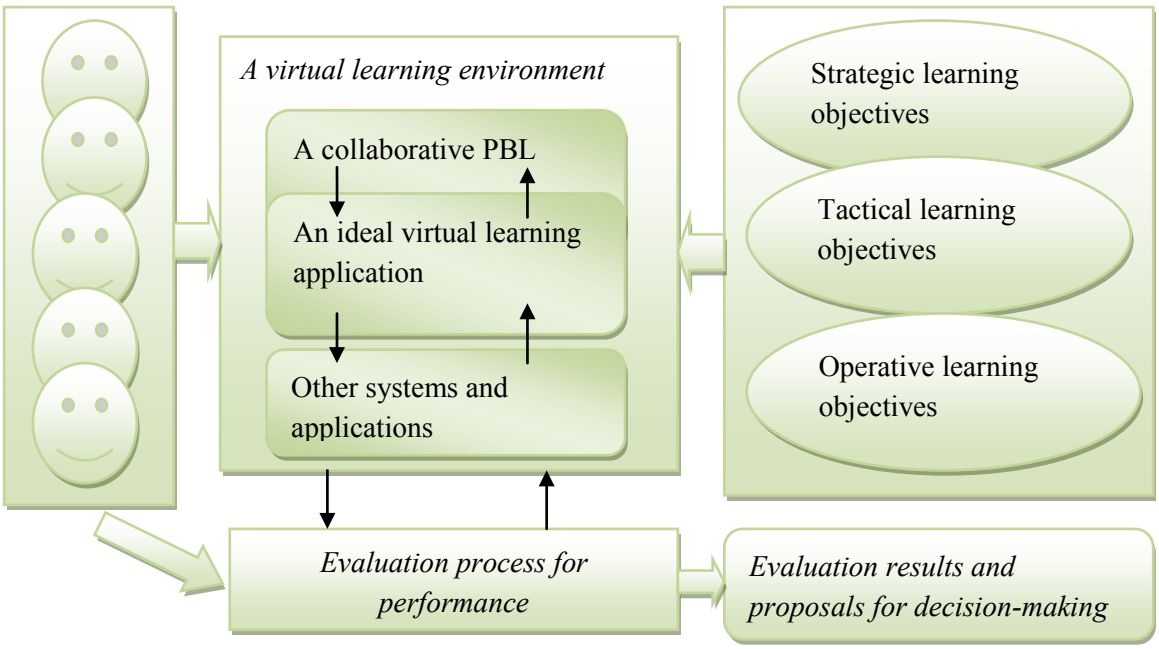

Figure 4.13 A virtual learning environment and evaluation process

In Figure 4.13, I represent an evaluation environment for an evaluation process for an ideal virtual learning application. The framework is conceptual, thus it includes learning objectives in strategic, tactical, and operative levels, and a collaborative problem based learning method is included, since it is selected for the learning method that is applied in the case organization. The ideal virtual learning application is identified, since it denotes the situation in an evaluation process, in which preferences of stakeholders, properties of virtual learning application are explored and identified by identifying all possible features that an ideal virtual learning application should fulfil. However, in reality, it is impossible to find out a virtual learning application, in which all components and properties are available.

Chapter five

5 Developing evaluation method and evaluation criteria

5.1 Introduction

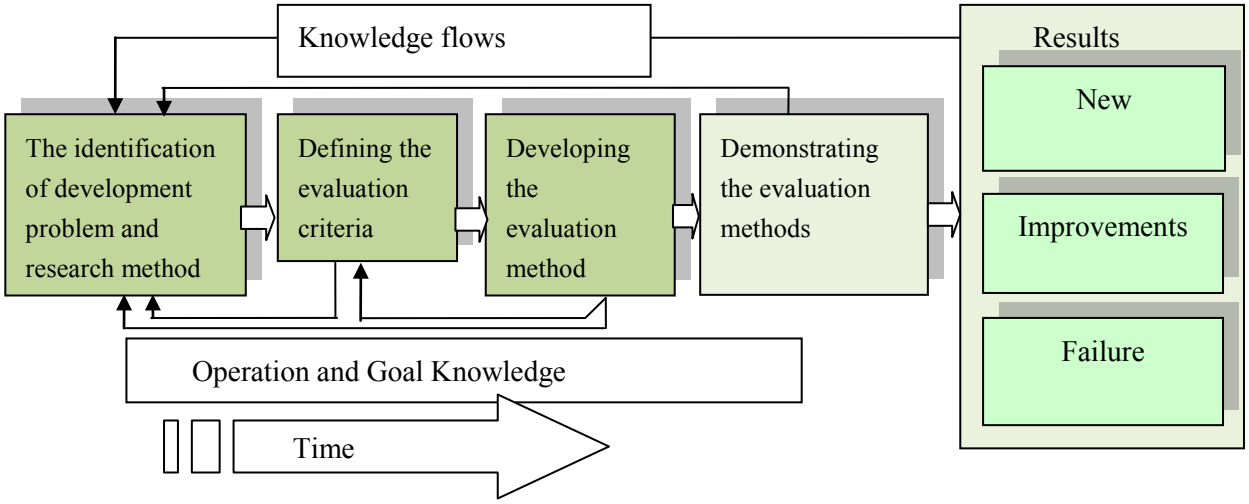

Figure 5.1 The structure of evaluation process stage developing model

In Chapter 5, available or used learning methods are analyzed, and how information technology is combined with the learning methods is researched. Some of the criteria are derived from the selected learning and method, and the structure of observed learning outcomes (SOLO) taxonomy, and these criteria are then used to create the first set of criteria for evaluation methods of stakeholder groups: these groups are student and teacher, and the second set of criteria is derived from the stakeholder preferences. The specified learning method is the collaborative problem based learning (CPBL). The third set of criteria consists of the properties of an ideal virtual learning application. This chapter is organized into the seven Sections.

In Section 5.2, three educational evaluation methods are investigated and the group support system model is presented. The first virtual learning applications were based on the available group support systems. Nunamaker et al. (1997) investigated group behaviour rules and group learning in the special learning situation in the US Navy and the concept ‘open discussion’ and the concept of ‘verbal walk through'’ were identified. The sequential writing process was also identified in this study. Britain and Liber’s fictional educational and pedagogical evaluation framework (EPEF) is described, since it is also based on discussions, the concept ‘dialogue’ is an important term in this framework. The concept ‘dialogue’ is applied from Laurillard’s research. Britain and Liber’s research papers (1999, 2006) show, how this evaluation framework

is developed and how it is used in evaluation for virtual learning environment in UK. Beer's Viable System model is a source of EPEF-model, and this model represents different systems and combines organizational levels to an evaluation framework. The DIANA-model is based on the concept of 'dialogue', which is specified as 'authentic dialogue between human beings'. The DIANA-model was used for a single export evaluation study. These educational evaluation frameworks and models are selected, since the research unit in all three was an educational system combining a virtual learning application. I point out, that the important concept in virtual learning is 'dialogue' according to these three evaluation methods. Discussion by using virtual learning applications as a tool is an important learning method to transfer knowledge and use codified knowledge for solving problems and developing problem solving skills.

Section 5.3 investigates a conceptual structure of an evaluation method for virtual learning application. The conceptual evaluation method structure is developed by using DeLone and McLean's IS success model (2003) and Alter's work system theory. Service quality component is analyzed by describing SERVQUAL-method, which is generally used in an evaluation process for information systems. In Section 5.4, a simple weighted values' evaluation method is represented for to demonstrate that subjective weight value model does not satisfy evaluation objectives, and that the proposals for decision making is not necessary good enough, even evaluation objects are based on an acceptable virtual learning system.

In Section 5.4, it is developed evaluation objects based on the specified collaborative problem based learning method. SOLO-taxonomy and properties of the collaborative problem based learning method build a base to link virtual learning systems to virtual learning application. The developed evaluation objects are created for an ideal virtual learning application point of view.

In Section 5.5, I will develop evaluation objects, which are based on the collaborative problem based learning method.

In Section 5.6, I will investigate the stakeholders' evaluation method for virtual learning application. Stakeholders are identified as the following groups: students, teachers, ITC-staff and executives.

In Section 5.7, the evaluation method of the specified stakeholder groups is investigated. The stakeholder groups are '*executive', 'ICT-staff', 'teachers' and 'students'*. The summary of the evaluation methods represents all stakeholders' groups evaluation methods and shows, which variables are used in an ex-ante evaluation process.

5.2 Educational evaluation methods based on dialogue

There exist virtual learning systems and applications that are based on the group support systems (GSS). I explored Nunamaker et al.'s work, when trying to find out how virtual learning systems are developed. Nunamaker et al. (1997) and Briggs et al. (1999) investigated group support systems (GSS), and they identified that discussions and generating documents can be described by using six steps (stages), which are the following:

a) Open discussion
b) Generation of a document outline
c) Discussion of a content outline
d) Composing by sub-teams
e) On-line feedback and discussion
f) Verbal walkthrough

The stages are clarified by using the following definitions:

a) Open discussion means that a team develops the objectives and a general scope of the document by using brainstorming or parallel discussion software to support this process.
b) The team creates the main section and sub-sections of the document,
c) An interactive generation and discussion of the document content.
d) After clarifying the content of a document, participants create sub-teams and make an agreement on what sub-teams are doing and developing for total document.
e) After each sub-team has done their work and delivered their part of the document to other sub-teams, they are ready to discuss and give feedback to each other.
f) Verbal walkthrough means that all members of a team analyse documents and they agree on the content or make their own proposals to the final documents. This collaborative writing process starts sequentially and continues on circular sub-processes.

The three first stages are sequential and the other stages are circular according to Nunamaker et al. (1997) in Figure 5.2.

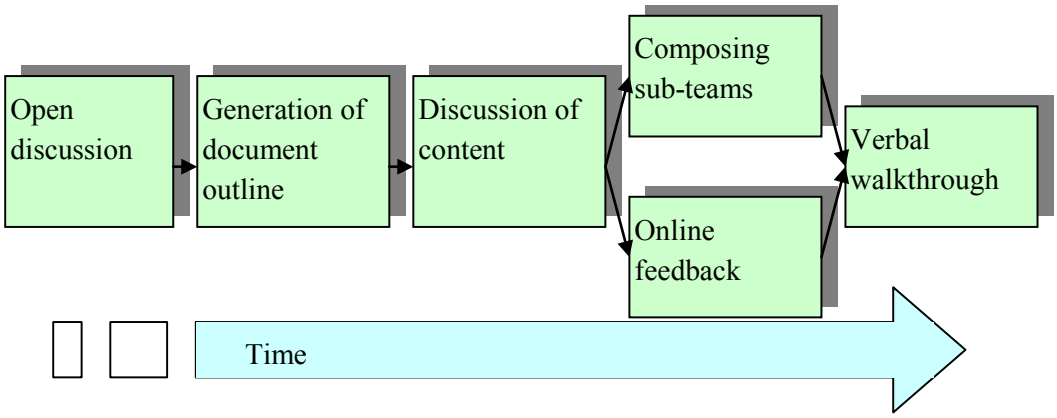

Figure 5.2 A collaborative writing process

In Figure 5.2, a collaborative writing process is presented, to demonstrate how a group writing process can be organized. Written documents are an essential part of the learning process, since at higher education learning results are documented by using text, drawings, videos and images. Therefore, I have described collaborative document creating processes. A sequential writing step describes the situation in which a learner is preparing a draft text for a shared document. Parallel writing and editing step includes iterative processes, when members of the group are continuing to write and edit draft text. It is assumed that a virtual learning environment includes shared writing tools, such as a general feature like a typical word processing tool. The reciprocal editing denotes the step when learners are reading and editing draft text in a way that a final report is possible to produce and all members of the group accept

the report's content. The final report is delivered as a paper in digital format to reviewers or teachers. The collaborative document creating process and the collaborative writing process are investigated, so that it is possible to develop an evaluation criterion based on these features (a current collaborative tool is wiki, as web 2.0 tools). A virtual learning application identifies and includes a database, a group support system application, a model database, a processor, a user interface. Procedures of group facilitating investigated by Kwok et al. (2002) used Turban's (1995) model of a group-supported system (GSS). The object of their pilot study was to find out how a virtual discussion in small groups and the externalization process are enhanced when using the GSS system as a tool. Kwok et al. (2002. p.105) found that "in the GSS supported CPBL environment, *externalization* of learners contributions were more critically focused on divergence of new ideas and quality of feedback, rather than the number of questions and feedback generated. In addition, learners were more willing to share their initiated ideas with the group than just asking help from the group."

The Association for Learning Technology (ALT) web site contains Cook's (2004) report, which includes a description of the possible analysis that can be used for evaluation processes. The list of analysis includes the following types of analyses:

1. *Need analysis, 2.fFormative analysis,3. summative analysis and 4. integrative analysis.*

Cook (2004) defines that a need analysis is "an assessment of the current situation and how the resource in question may help. Formative involves collecting information about a prototype resource in order to improve usability and refine content etc. Summative takes place at the end of the development cycle, in order to demonstrate the effectiveness of the resulting resource." Cook's identification of the integrative analysis includes "looks at how the resource can be best integrated with all other resources that are available to its users."

I point out that the needs analysis should identify the current situation and the stakeholders' requirements (preferences) of a virtual learning application. I emphasize that formative analysis includes properties of a virtual learning application, when it is identified as a package of virtual learning application. I point out that Cook's statement seems to be suitable, when we are developing in-house application or acquiring an application, which is produced by using the requirements analysis.

Britain and Liber (1999) developed a fictional Educational and Pedagogical Evaluation Framework (EPEF) as they called it. It seems that the fictional framework is based more or less on an available virtual learning environment at that time. Those components are presented in boxes, but there are no relationships mentioned on how these should be linked to each other, so it is difficult to see, if there are any links between components. I suppose that the components are independent artefacts, applying Iivari's definition of the artefact. Britain and Liber used these components to represent properties that should exist in an ideal virtual learning environment. In order to clarify the meaning of the components, they are presented in Table 5.1 in alphabetical order, since Britain and Liber do not give any order. I give a short description of a component, as I understand the components according to Britain and Liber's text.

Table 5.1 The components of virtual learning environment.

Component	***Description***
Assignment	A tutor and teacher can create course assignments for students to complete as they read, and they do their work during the course period.
Assessment	A virtual learning environment (VLE) includes on-line quizzes for getting feedback and information about performance, and carrying out self-tests.
Calendar	A calendar is included in a virtual learning environment (VLE) and tutors, teachers, and students can put their sessions and other meetings to the calendar and everyone can browse through this information.
Bookmarking	Bookmarking is a property that can be used to create a personal resource base for frequently used data.
Conferencing Tools	Asynchronous Discussion Tools are available for tutors, teachers, and students for sending and receiving information.
Class lists	A class list includes students', teachers' and tutors' names, and a short description of background data of each.
Course Outline	It includes an overview and schedule of each course that are included and available on the Virtual Learning Environment.
E-mail	The E-mail component can be built-in at each VLE or E-mail applications can be a general e-mail application that is connected to a VLE.
File upload area	A virtual learning environment allows tutors, teachers and students to upload and download their own material for others to read and see. The multi selection property for uploading and downloading is preferable properties for a VLE.
Home Pages	Some VLEs include a built-in HTML-editor for creating personal Home Pages.
Metadata	Metadata means that a VLE includes information about an object and this information is built in using the Dublin Core, or LOM, or SCROM standard.
Multimedia recourses	A VLE allows easy use of multimedia recourses to access rich data and store it to the course folder area.
Navigation Model	VLE allows the navigation through course material using Client Server architecture or tree structure. Britain and Liber expect that other architecture model will bepossible in the future.
Notice-Board	It includes announcements and news on the main page and students or teachers can see them after logging in.
Search Tools	A VLE must include a searching tool that everyone can use during the course period.
Synchronous Collaboration Tools	A VLE may allow students, teachers, and tutors synchronously use Chat, use a Shared Whiteboard, use Group browsing, and Video Conferencing Tools.

Britain and Liber used their EPEF-model, when analyzed the following virtual learning applications and environments:

1. *Course Management Tools*
2. *Interaction Tools*
3. *Learning Management Tools*
4. *Resource Management Tools*
5. *Staff Management Tools*
6. *Student Tools*
7. *Student Management Tools*
8. *Teacher Tools*

These applications and environments are presented in Appendices 1 and 2. The analysis includes 12 applications and environments. Britain and Liber use the concept 'tool', when describing the components of virtual learning environment.

The property categories are presented by using yes/no scale, which reveals that identified property exist, but do not offer the evaluation of the quality of property. Britain and Liber (1999) emphasize that the network learning application (NLA), has to meet at least two objectives. The first objective is *virtual learning must provide opportunities to improve the quality and variety of learning and teaching*. The second objective is *possibilities of reducing administrative work of the teachers*. Britain and Liber (1999, 2006) stated that the first objective is directed to students as learners and the second objective is a managerial objective; even it is identified as the object of teachers.

Lambert and Williams (1999) also consider the quality of learning and teaching when they investigated a model for selecting educational technology at Flinders University of South Australia. Britain and Liber's (2006) revised framework for pedagogical evaluation of e-learning is based on two different theoretical models. The first model is the conversational framework (CF) developed by Laurillard (1993) and the second is the Viable System Model (VSM) identified by Beer (1981). Laurillard developed her model for higher educational teaching, when she recognized that teaching at universities should be based on *dialogue*. Laurillard (1993, pp. 94 - 95) stated: "The learning process must be constituted as a dialogue between teacher and student, operating at the level of academic knowledge."

Beer's (1981) viable system model is based on his ideas of the management cybernetics, which he identified and developed since 1960s. The viable system model consists of five systems, which are described in Figure 5.3. The modified viable system model is developed by using the original viable system and Britain and Liber's (2006) model. All five systems of the viable system model are recursive by definition. Therefore, each system includes other systems. The concept 'Algedonic Alert' is used to denote alarms and reward, when learning and teaching processes fail or exceed the capacity. The outer circle is added to Figure 5.3 to denote the society, which stress the situation that teaching and learning system is an open system.

By representing the modified viable system model for teaching, I point out the recursive nature of teaching should be taken into account, when identifying an ideal virtual learning application and its properties. ***System five*** in the viable system model includes organizations' mission and vision, the executives' point of view a strategic decision in learning and virtual learning applications stress the need that decision-makers should take into account organization's mission and vision, how learning processes are arranged in the future. ***System four*** includes tactical learning objectives and applied learning methods that are used in formal learning and teaching processes. ***System three*** includes operative decisions, and organized and arranged learning processes in the curriculum year. ***System two*** is described as an independent component, which includes regulations, rules and controls. The auditing processes are included in system two, which will point out the situation, where auditing is carried out by a special auditing unit or organization. ***System one*** describes how learning courses are arranged and how learning and teaching processes are carried out. Relationships are described between systems in a hierarchically top down way and relationships are dyadic, the higher level affects the lower level and feedbacks are used for the re-evaluation of decisions.

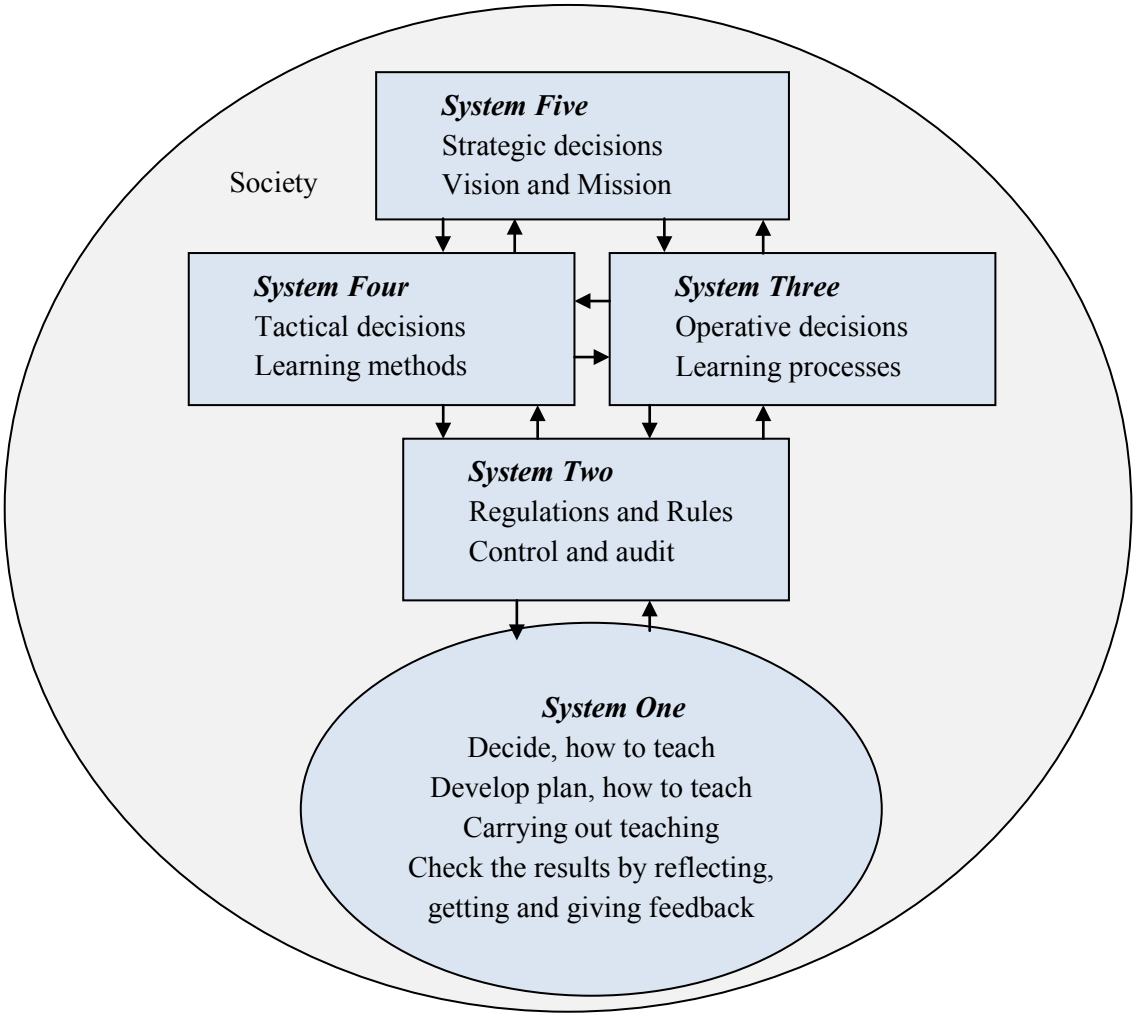

Figure 5.3 The modified viable system model for teaching.

In Table 5.2 the evaluation properties that are the basis for evaluation criteria are presented. *"Discursive"* is a property that will be evaluated and an evaluator set value of the discussion using selected scales. *"Adaptive"* is a property that defines how teachers and learners can communicate in a group. *"Interactive"* is a property that denotes how group interaction between members and with a teacher is organized. An interesting property is *"Reflection",* since it denotes that reflection may happen virtually.

Table 5.2 Key characteristics of Conversational Framework.

Evaluation property	***Description***	***Tools***
Discursive	Students' and Teacher's conceptions are accessible to the other. Students and Teacher agree about the learning goals. The teacher provides an environment within which the students can act on, generate and receive feedback on the appropriate descriptions to the topic goal.	E-mail Discussion lists Chat
Adaptive	The teacher has the responsibility to use the relationship between his/her own and the students' conception to determine the focus of the dialogue.	Units of learning material can be hierarchically structured. Schedule and timetable and time restrictions.
Interactive	The students must act to achieve the task objectives. The teacher must provide meaningful intrinsic feedback on the actions that relate to the nature of task objectives.	The interactive environment. Students and teacher can create group and sub-groups. The members of the group can discuss and change ideas.
Reflective	The teacher must support the process in which students link the feedback of on their actions to the topic objectives for every level of description within the topic structure.	Students can view their own test scores. Individual feedback and group feedback can be provided.

The evaluation objects in Table 5.3 include adaptation, coordination, individualization, monitoring, self-organization, and resource negotiation, which are based on Beer's (1981) Viable System model (VSM) differ from the evaluation characteristics in Table 5.2. I point out that these objects should be identified when developing evaluation criteria based on the learning methods. It is also interesting to think about how teams work together and especially how they support the collaborative writing process. A typical team starts to work with one member of the team creating a report concept and then the team should start to work together and continue using different kinds of writing process. The process is described in the Figure 5.2. According to Britain and Liber, the collaborative writing processes need to be structured, since the structures are sequential and partly circular.

Table 5.3 Evaluation criteria of the VSM approach (Britain and Liber, 1999).

Evaluation objects	*Description*
Resource Negotiation	A resource library is available within the system as are places for students to do their own work.
Coordination	Collaborative working is possible. Group and sub-group are allowed.
Monitoring	Teacher and tutor can monitor current discussion and take part in it.
Individualization	Students can use and find their own material during the studying process. Students have access to previous students' work. There is list of experts who can provide advice on selected topics.
Self-Organization	Students can organize their own work groups and sub-groups.
Adaptation	Teachers can adapt their teaching to the needs of their learners.

Dialogical Authentic Net-Learning Activity (DIANA) Action-Model developed by Aarnio and Enqvist (2001), investigate a learning model. The model is based on the ideas of an actual dialog between two human beings. The definition: "Dialog means people's equally participated thinking and deep knowing something or a certain action." In the dialog process, every participant is a subject (2001, pp.15 -16). In order to achieve results during the dialog process, it is assumed that all members of the group are willing to discuss and share knowledge, and the group together creates something new, which has an unknown meaning for everyone in the discussed matter. It can be said that through this, the group or team has achieved a deeper and better understanding of the subject. These criteria were developed during the VETO project and the criteria were used in Aarnio et al.'s (2002) expert (independent observer) opinion study. The researchers carried out an evaluation using qualitative analysis only and marked the properties existing or not existing, but the evaluator did not use any values or scale to evaluate the defined properties or compared properties. A multinational research group that has developed a virtual learning application called Future Learning Environment (FLE) identified four infrastructures, which has an impact on efficient learning (Lipponen 2002, Rahikainen et al. 2001, Hakkarainen et al. 1999). The computer-supported intentional environment (CSILE) research group defined the four infrastructures that have an impact on efficient learning:

1. *Technical infrastructure,*
2. *Pedagogical infrastructure,*
3. *Social infrastructure*
4. *Epistemological infrastructure*

The definitions of the four infrastructures were created according to the research groups:

1. "Technical Infrastructure: Teachers, students, or other participants need to have an access to new technology in their everyday working environment as well as sufficient ICT skills. It often

takes a long time to learn to use new technology in a flexible way and integrate it with one's own activity.
2. Pedagogical Infrastructure: There have to be practical and workable pedagogical models that help to find meaningful ways of using new technology for solving problems, collaborating, building knowledge and networking with external communities.
3. Social Infrastructure: New technology should be an integrated aspect of core educational processes rather than a separate activity. It is essential that building of a new culture of collaborative learning and knowledge building be supported by content of curriculum, structure and organization of courses and activities as well as assessment practices. It is important to induce the whole teacher community to engage in professional development, to have parents closely involved, as well as to obtain support from local community.
4. Epistemological Infrastructure: Teachers, students and other participants need to develop epistemological awareness of categories of knowledge and processes of inquiry in order to be able to appreciate the value of pursuing questions or explanations and engaging in deepening inquiry."

When evaluating virtual learning environments members of the CSILE group argued that only three virtual learning environments exist at a time, which fulfil the infrastructure requirements for collaborative learning. The first and original one according to them is: 1) Knowledge Forum and the others are: 2) Future Learning Environment and 3) WorkMates. They point out that the second and the third ones are based on the Knowledge Forum. The members of the CSILE group argue that if the infrastructures are not prepared and are not functional, then the quality of learning will be poor. By considering four infrastructures: technological, pedagogical, social, and epistemological. It seems that these are strong premises, and I can argue that at the beginning of virtual learning all the premises may be valid. When I try to apply the defined premises to the ex-ante evaluation process, it can be argued that the technical, pedagogical, and social infrastructure as components are essential elements and these should take in the evaluation method into account or at least identify, why these components are missing. I point out that epistemological infrastructure will be difficult to use as an evaluation method.

By comparing Nunamaker et al.'s GSS-model (1997), with Britain and Liber's EPEF-model (1999), and with Aarnio and Enqvist's DIANA-model (2001), I point out that all these models are based on the concept of dialogue. Nunamaker et al. developed GSS-model by analyzing discussions in a special work system (US navy); Britain and Liber developed and analyzed learning and teaching in the higher education environment taken into account Laurillard's concept of dialogue (1993) and Beer's viable system model. Aarnio and Enqvist investigated formal vocational teaching and learning by doing, when they developed the DIANA-model. The dialogue and explicit knowledge and implicit knowledge (tacit knowledge) are essential concepts, when I try to analyze, how human beings learn and use codified knowledge. Anthony's (1965) three level organization and Beer's viable model system (1981) included *strategic, tactical and operative levels* in an organization point out, that socially constructed reality is an important element in formal learning and teaching. The levels of organization define how evaluators create and use their preferences and multiple objectives in an evaluation process, since power and position in the organization may affect an evaluation. The processes of knowledge describe how human beings use knowledge in learning and teaching, I have to

recognize, when I am describing an ideal virtual learning application and its properties. Orlikowski's practices of knowledge processing (2002) and Lundh Snis' practices of codifying knowledge (2002) create a base to identify needed processes of an ideal virtual learning application.

5.3 The evaluation methods for virtual learning application

In Chapter 4, I defined that the process model of evaluation for virtual learning environment can be represented by integrating updated DeLone and McLean IS success model (2003), the objectives of learning organization, so that I can evaluate virtual learning application independently. In Figure 5.4, I try to describe how virtual learning application's relationships with learning method and other systems in the virtual learning environment may affect reality. The conceptual evaluation method is developed by using Alter's work system theory, so that our conceptual evaluation method combines DeLone and McLean IS success model and virtual learning system.

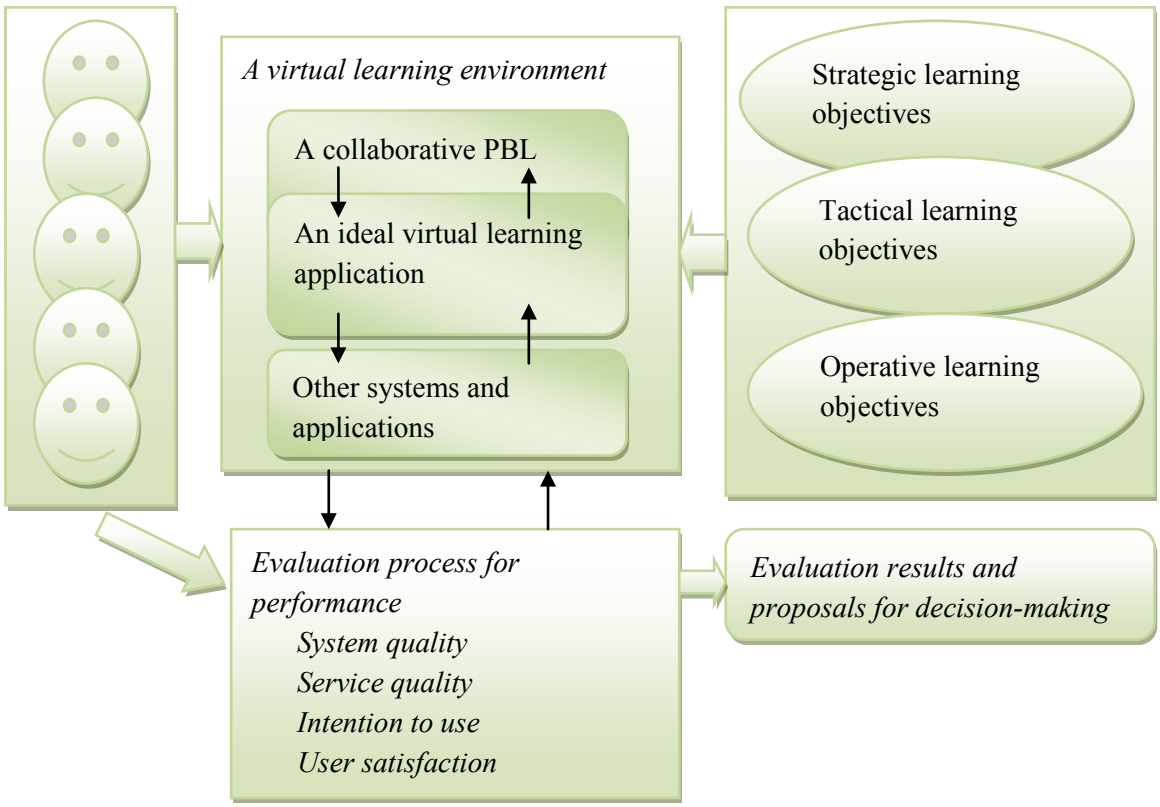

Figure 5.4 A virtual learning environment and evaluation process

In many research papers, System quality is measured according to Petter et al. (2008) by using the following properties (Sedera et al. 2004): *ease of use, ease of learning, user requirements, system features, system accuracy, flexibility, sophistication, integration and*

customization. ICT departments' service quality is generally measured by using SERVQUAL-method. According to Pitt et al. (1995), SERVQUAL-method should be used by recognizing its strength and weaknesses, when evaluating information systems. Sedera et al. identified the following properties, which were used to measure individual and organizational impacts (included in net benefits in IS success model 2003). Individual impacts: *learning, awareness/recall, decision effectiveness and individual productivity.* Organizational impacts: *organizational costs, staff requirements, cost reduction, overall productivity, improved outcomes/outputs, increased capacity, e-Government and business process change.*

In measuring service quality in an ex-ante evaluation process, it is difficult to use the SERVQUAL-method since I can only evaluate expected value, but not perceived value. Because I am able to use perceived values, I should during a selection process experiment or test possible virtual learning applications, and in reality this is seldom carried out. The original questionnaire service quality is utilized by using expectation and evaluation scale Likert's items starting from strongly disagree = 1 and ending to strongly agree = 7. The generally accepted service quality measure is the following formula: difference score $G = E - P > 0$, where $E = 1/n\sum e_i$ and $P = 1/n\sum p_j$, where n is number of expectation variables and number of perception variables. In the original version the number of variables is 22 for expectation and for perception. The SERVQUAL-method is identified as five dimensional and the dimensional names are 'tangible', 'reliability', 'responsiveness', 'assurance' and 'empathy'. The dimension 'tangible' is criticized, because it measures facilities, which cannot be observed directly. In a virtual service situation, this dimension needs other variables to identify. It is interesting to recognize that in theory, I can propose the following values of service quality difference score:

$G = E - P = 0$, service quality level is as expected equals perceived
$G = E - P < 0$, service quality level is better than expected
$G = E - P > 0$, service quality level does not meet expectation.

When Likert's item and Likert's scale are used, as described above, I can calculate an expected service level score per variable, the average difference score = 4.0, and if the geometric average (mean) is used, the expected geometric average difference score = 3.8. In decision-making point of views, the SERVQUAL-method includes the correct concept of service quality, since a users' or customers' expectations sets the standard of service level, which satisfies expectations and observed perception can be used to measure, if the expected service quality is achieved in the real service situation. However, the average difference scores cannot be directly used as guidelines, which kinds of actions are needed to satisfy users' expectations. A statistical measure that can be used to specify when actions are needed is a standard deviation. If I assume that the difference is more than one standard deviation, then actions are suggested for managers. I point out that, if the number of answerers of a survey is small, then the achieved results are not valid or reliable.

5.4 Demonstrating a simple weighted value evaluation method

By demonstrating a simple weighted value evaluation method, I developed an evaluation method based on the DIANA model. Aarnio et al. (2002) used this model as a source of evaluation objects, when a qualitative evaluation method was carried out by expert evaluation and the evaluated virtual learning applications were WebCT, Lotus Learning space forum, R5 Generation 3.2, Discendum Optima, Efodi 3.0 and FLE2. The purpose of evaluation was to analyze how well evaluated virtual learning applications meet the requirements of the DIANA model. Table 5.4 represents evaluation objects of the DIANA evaluation method. A general result of a qualitative evaluation process is that all evaluated virtual learning applications are usable for the DIANA learning and teaching process. I point out this result is not usable from the decision-making point of view, since it needs other analyses, how to select a virtual learning application, which is based on the proposed priority order of virtual learning applications or a decision maker has to use subjective criteria.

Table 5.4 Evaluation criteria based on the Diana action model.

Evaluation object	***Description***	***Tools***
Structure of the learning process	Teacher can easily create courses and linearly or non-linearly organizes the structure of the courses. Teacher can support and give advice to students' learning. Students can easily plan their learning and see the results of their work and outputs.	Ability to build modules. Independent and dependent modules. Calendar. What - if structures. Course statistics. Course analyzing tools. Learning Follow up –tools
Dialogical structure	Students can communicate synchronously, and a-synchronously. Students and tutors can re-organize the discussion chains. Teacher can categorize discussion.	Discussion classification tools. Discussions threads Tree structure. Selection tools. Categorizing tools. Working space.
Teacher's action and tools for dialogical learning process.	Students and teacher have own personal working place and space. Teacher can see student's personal working areas.	Personal working place and space tools. Temporary places. User rights tools.
Group support system and reflective scoring.	Students can create groups and participate in other groups and take part in the discussion. Student can see previous discussions.	Group creating and managing tools.
Portfolio	Students can build own Learning folder and save outputs. Student can manage own Learning folder.	

Teacher ability to use learning application	Teacher learning level and ability to use and manage necessary Software.	Text-processing tools Html-editors. Image editors. Video editors and multimedia tools.
Technical Usefulness Logical action Navigation Multimedia elements	Learning application logical action. Navigation logic. Used symbols. (Windows-likeness). Possibility to add and use multimedia elements easily.	Menu structure Tool bars Symbols. Navigation tools.
Technical platforms	Operating systems. User management. Security Server and devices Databases Workstation Mobile devices Handheld (Palm) devices. Network requirements Browsers	

I point out that, the DIANA model is used as an example for developing the selection criteria of the collaborative group learning evaluation method (CGLE) and that evaluation method can be presented as:

CGLE = f(LPS, LPC, LPD, LPT, LPR,P), where
LPS = Learning process structuring
LPC = Learning process classification
LPD = Learning process dialog
LPT = Learning process tools
LPR = Learning process reflection
P = Portfolio tools

By developing the criteria further, it can be expressed by multiplying each variable value by its weight coefficient, which is a better way to implicate the importance of the property. The weakness that is included in the weighted evaluation methods is that the weight value is subjective and depends on the developer's priorities of evaluation objectives. Our definition for the collaborative group learning evaluation method is presented in the following formula:

$$CGLE = \sum_{i=1}^{n}(w_i o_i^{am}) = w_1 o_1^{a1} + w_1 o_n^{am} + \ldots + w_n o_1^{am} + w_n o_n^{am},$$

where w_i = the weight coefficient of variable i and o_i = opinion value of variable i of the virtual learning application i, and ^{am} denotes alternative.

The basic assumptions of these criteria are that the impact of the criterion is linear and the presented evaluation method is summative. Table 5.5 shows an example of the results obtained by using a CGLE evaluation method. The virtual learning applications are fictive and the evaluation criterion measurement scale is 0 = property does not exist, and 1 = property exist. By producing the fictive results from the CGLE evaluation method example, the purpose is to show that the evaluation method can produce results. The fictive results show that values depend on the weight factors and if using on exist/non-exist scale, the evaluated virtual learning applications can be ranked in order by using defined properties.

Table 5.5 Example of CGLE evaluation method

		Evaluation scale (yes=1/no=0)				*Weighted results*			
Property	*W*	*Vla1*	*Vla2*	*Vla3*	*Vla4*	*Vla1*	*Vla2*	*Vla3*	*Vla4*
LP structuring	1,5	1	1	0	0	1,5	1,5	0,0	0,0
LP classification	2.0	0	1	0	1	0,0	2,0	0,0	2,0
LP dialog	2,0	1	1	0	1	2,0	2,0	0,0	2,0
LP tool	1,5	1	0	1	1	1,5	0,0	1,5	1,5
LP reflection	2,0	1	1	1	0	2,0	2,0	2,0	0,0
Portfolio	1,0	1	0	0	1	1,0	0,0	0,0	1,0
Total	10,0					8.0	7,5	3,5	6,5

I argue that by using weight values and a qualitative scale, we are able to show simple differences between the alternatives and to set rank in order according to the sum of weight values, but we are not able to show ordered preferences of the properties of a virtual learning application. The term ‘alternative’ is used as a synonym of a virtual learning application. By presenting the example, I try to show that a simple weighted value in an evaluation method does not reveal preferences that can be important factors in a decision-making process.

5.5 Evaluation objects based on the collaborative problem based learning method.

The collaborative problem based learning evaluation method (CPBLEM) includes variables of course content preparing and transferring, session discussion tools, knowledge sharing and creating tools, reflection and evaluation tools and both students and tutors need tools for meta learning. Meta-learning tools are needed to develop problem-solving skills. The criteria are based on the SOLO taxonomy and the collaborative problem based learning method investigated in Chapter 2. The evaluation objects and variables of the evaluation method are presented in Table 5.6. I point out that our evaluation method CPBLEM is ideal, since it includes the properties of a virtual learning environment (tools) that are demanded or wanted. However, in reality, they do not all exist in the available virtual learning environments (applications). The descriptions of evaluation objects are based on partly Biggs’ (2001, p. 9) idea, however, most of

the descriptions are our own descriptions. The meta-learning objects are based on Biggs' investigation of the knowledge process in learning.

Table 5.6 Evaluation object based on the CPBLM and variables

Evaluation object	*Description*	*Variable of the method*
Course content tools	Course content tools can be utilized to produce course content by facilitators, teachers, or even learners.	cpl1
Course instruction tools	Course instruction tools are used to develop course assessment and learning instructions.	cpl2
Discussion forum	Discussion forum is defined as a virtual learning environment (application) that includes both asynchronous and synchronous discussion applications.	cpl3
Asynchronous discussion	Time-independent discussion tool	cpl4
Synchronous discussion	Time-dependent discussion tool	cpl5
Session tools	Session tools are used for setting questions to the other learners and tutors. Session tools include questioning, inquiring, possible advanced agent (application that can virtually answer questions by using databases)	cpl6
Questioning tool	Questioning tool offered to the learners to create questions and leave them for other learners or tutors	cpl7
Inquiring tools	Learners are using inquiring tools to ask and get more knowledge concerning the learning object and problems.	cpl8
Advanced agent	An advanced agent is a virtual tool for learners and it can be possible to deliver more questions or inquiries or answer open questions if a knowledge database is available (FAQ-database). Advanced agent includes artificial intelligence in the network based on the knowledge database.	cpl9
Searching tool	A virtual learning environment includes an advanced searching tool for knowledge retrieval.	cpl10
Conferencing tool	A conference tool in a virtual learning environment means, that learners and tutors can virtually create a conference so that learners can participate on campus or at home and in classrooms.	cpl11
Shared knowledge tools (Text-based knowledge)	The shared knowledge tools provide the learner with a way to read and write by using shared knowledge.	cpl12
Reading knowledge tool	Members of the group can virually read and comment on learning material and can use a shared reading	cpl13

	knowledge tool.	
Writing knowledge tool	Members of the group use a shared writing knowledge tool to produce text or other object at the same time and in the same report.	cpl14
A shared searching tool	A shared searching tool provides the learner with a tool that can be used to search for reading or writing material for learning and producing personal portfolios.	cpl15
Voice over IP tool	A voice over IP tool offers a way to use phone (mobile phone) for recording discussions.	cpl16
Drawing tool	By using a whiteboard, learners and tutors can visualize thoughts and draft ideas so that others can comment and take part in discussion and further develop ideas together.	cpl17
Recording tool	The learners and tutors can record videos and discussion and save results to the server for later use.	cpl18
Reflection tools	Authentic feedback virtually is a demanding process and it requires that learners and tutors can communicate open-mindedly, since body language is not possible or it requires that the learners and tutors can use web-camera.	cpl19
Self-reflection tool	A self-reflection tool is used to evaluate ones own learning processes and learning results and save them in a personal portfolio.	cpl20
Group member reflection tool	The reflection tools are used for critical appraisal of members' activities in group sessions and meetings. The reflection tools are used to give and get feedback in a group learning process and activity of the members in sessions.	cpl21
Tutor reflection tool	The reflection tool for tutor appraisal provides in a way of giving and getting on-time feedback about course content and course organization and the role of the tutor in sessions.	cpl22
Meta learning tools	Meta learning tools provide the learners and tutors with a tool developing professional thinking skills. The learners are capable of high abstract thinking and can produce theory, generalize, set hypotheses and reflect. The big question here is how I can describe meta learning thinking tools or for that matter, it is only possible to evaluate or measure for learning results afterwards.	cpl23
Uni-structural thinking tool	The learners are capable of identifying problems and creating simple procedures. What is the meaning of the term "mental thinking"? Are results measurable?	cpl25
Multi-structural thinking tool	Learners can enumerate, describe and create lists, combine things and produce algorithms.	cpl26
Relational thinking	Learners can compare, contrast, explain causes and	cpl27

tool	analyse phenomenon, and learners are capable of relating thing to new phenomena and apply learned knowledge to new areas. Here I can use the concept "knowing" to denote that a learner possess a deep understanding of the phenomenon.	
Scientific thinking tool	The learners are capable of extending abstract thinking and can produce new theories and theoretical models.	cpl28

Table 5.7 represents evaluation objects (properties of the virtual learning environment), which are used to develop our evaluation method of the collaborative problem based learning method; the following function denotes the evaluation method of virtual learning application for collaborative problem based learning method:

$$CPBM_j = \sum_{i=1}^{n} w_i * cpbl_{ij},$$

where w_i is the weight of a variable i and $cpbl_{ij}$ is the value of a variable i for the virtual learning application j and n is the number of variables in the evaluation method. Variable $cpbl_{ij}$ represents variables defined in Table 5.7 that will be included in the evaluation method. I emphasize that Table 5.7 defines the properties of the virtual learning environment for the collaborative problem based learning method. However, a virtual learning application is part of a virtual learning environment, and a virtual learning application does not include all properties, since some of the properties belong to the content management system, learning management system and some of the properties are typical to content producing applications. In the function $CPBEM_j$ the weight values will be calculated by using the AHP method. The AHP matrix calculation is carried out by comparing selected evaluation criterion pair-wise by using a scale from 1 to 9.

5.6 Stakeholders' evaluation methods for virtual learning applications

In this study, I use the following stakeholders, which were identified in Chapter 4. The 'developers' are not explicitly included in this study, since the purpose is to evaluate a package of a virtual learning application, and I can argue that developers are members of ICT-staff.

The first stakeholder group is top management (including headmaster, deans and directors), and I am using the concept "*executives"* as a synonym for top management. The second stakeholder group is faculty members (including professors, lectures, and teachers) and the term is *"teachers"*. The third stakeholder group is "*ICT-staff"* (including ICT managers and developers). The fourth stakeholder group is "*students"* (including undergraduate and adult students). The evaluation method for stakeholder groups is derived from the collaborative problem based learning method, since I defined in Chapter 2 that the purpose of the study is to define evaluation methods, so that learning methods are taken into account. I identify an evaluation method for each stakeholder group from a students and continuing to teachers, ICT-staff and executives groups.

In the evaluation situation, in which students are an evaluator group, Phillips and Gilding (2004) offered advises that should be taken into account "While we might evaluate the usefulness of ICT in an educational context, we also need to research how ICT can affect the processes of learning, and what learning outcomes are achieved." They proposed "systematic evaluation research needs to go beyond perceptions, and needs to have a clear purpose. A useful distinction is between formative and summative evaluation." They emphasized, "… formative evaluation focuses on improvements to products and processes, which are being developed, while summative evaluation focuses on the effectiveness of the finished product." It is also good to recognize that formative evaluation does not only concern itself with the ICT product, but also with the learning processes of students and our performance as teachers. Phillips and Gilding's evaluation guides also point out that in order to utilize the summative evaluation to measure the effectiveness of ICT on student learning, "… we first need ICT-tools, which works in the way that it is expected. We also need clear vision about the type of learning the ICT-tools are available. This means we must be aware of research on student learning."

Phillips and Gilding's proposals is included in the Evaluation cookbook by the Learning Technology Dissemination Initiative (LTDI) and have good guidelines for when planning an evaluation, by using students as a source of evaluation data. According to Harvey (1998), the editor of the evaluation cookbook, the term 'pre' and 'post test is used to identify an evaluation process, while I am using the term 'ex-ante' and 'ex-post'. The suggested evaluation method is a questionnaire in the Evaluation cookbook.

In the next sections, I define students as a user of a virtual learning application. I believe that students are important users, so I try first to describe evaluation method by defining evaluation properties and evaluation variables for the students. Teachers are also regular user of a virtual learning application, so their evaluation preferences and evaluation variables are defined the next section. ICT-staff's role is to provide support for students and teachers for use of a virtual learning application. By considering ICT-staff's role and ICT-staff preferences, I define evaluation variables by taken their role as a supporter into account. Executives' role in an evaluation process is to decide and to confirm that selected virtual learning application fulfils the defined objectives and cost-benefit calculations are carried out.

5.6.1 Stakeholder group students

The student as a user of a virtual learning application preferred properties that can be best described as 'ease of use' and that is defined in the evaluation method as login/logoff, which means that students suggest that they can login to the virtual learning application by using their network username and password without using different username and password. This property is selected after discussing with undergraduate and adult learners. I use the term 'usability' to denote performance of a virtual learning application.

The selected evaluation criteria are defined in Table 5.7. Evaluation preferences are derived partly from the collaborative problem based evaluation method and partly from a general artefact's property such as login/logoff and file handling.

Table 5.7 Student's evaluation objects for the evaluation method

Evaluation preference (object)	*Description*	*Variable in the model*
Login/Logoff	Represents ease of use in a way that students prefer to use network username and password when logging in to the virtual learning application.	vlacs1
Asynchronous discussion (chat)	Students prefer to use a simple discussion tool for questioning and inquiring.	vlacs2
Synchronous discussion forum	Online discussion is a communication tool for students and tutors to share knowledge at specified time.	vlacs3
File handling	File handling denotes opening, saving, retrieving, sending files, deleting and sharing files.	vlacs4
Writing files	A writing tool for creating independently and for shared document writing by groups.	vlacs5
Reading files	Reading files denotes that students and tutors can read saved files easily by using viewers.	vlacs6
Viewing files	Viewing files includes different types of files (text, picture, video and animation).	vlacs7
Searching files	Searching files denotes that during the virtual learning application session, students and tutor can start a searching tool and find the needed knowledge.	vlacs8
Questioning	A questioning tool makes it easy to send questions to other students and tutor.	vlacs9
Reflection and evaluation	Virtual reflection and evaluation is a property that is suggested but may not exist in a virtual learning application	vlacs10

The student's usability evaluation method (SUEM) for virtual learning application is represented here:

$$SUEM_j = \sum_{i=1}^{n} w_{i*} vlacs_{ij},$$

where w_i is the weight of evaluation criterion i and $vlacs_{ij}$ denote evaluation criterion i for the virtual learning application j.

5.6.2 Stakeholder group teachers

Teachers prefer mostly similar properties than students. However, they also have a facilitator's role, so the properties "course content", "questioning" and "testing" are included in the teachers' evaluation method. In Table 5.8, teachers' preferences for evaluation method for a virtual learning application and the variables are defined and presented in Table 5.8.

Table 5.8 Teacher's evaluation objects for the evaluation method

Evaluation preference (object)	***Description***	***Variable in the model***
Login/Logoff	Represents ease of use in a way that teachers prefer to use network username and password when logging in to the virtual learning application.	vlact1
Course content	Course assessment and course description and study schedule can be produced by using standard office tools.	vlact2
File handling	File handling denotes opening, saving, retrieving, sending files, deleting and sharing files.	vlact3
Asynchronous discussion (chat)	Teacher (tutor) can send and get short inquiries from the students when he or she is able to work by using a virtual learning application.	vlact4
Synchronous discussion	Online discussion is a communication tool for students and tutors to share knowledge at specified time.	vlact5
Writing	A writing tool for creating independently and for shared document writing by groups.	vlact6
Reading	Reading files denotes that students and tutor can read saved files easily by using viewers.	vlact7
Viewing	Viewing files includes different types of files (text, picture, video and animation).	vlact8
Searching	Searching files denotes that during the virtual learning application session, students and tutor can start a searching tool and find needed knowledge.	vlact9
Questioning	A questioning tool makes it easy to send questions to students and other tutors.	vlact10
Testing	Teacher and tutor can organize a test and learning feedback appraisal virtually.	vlact11
Reflection and evaluation	Virtual reflection and evaluation is a property that is suggested for use but may not exist in a virtual learning application.	vlact12

The teachers' evaluation method is defined by using evaluation preferences in Table 5.9 and the formula is:

$$TUEM_j = \sum_{i=1}^{n} w_i * vlact_{ij},$$

where w_i is the weight of evaluation criterion i and $vlact_{ij}$ denotes the evaluation variable for criterion i and the virtual learning application j.

5.6.3 Stakeholder group ICT-staff

The third evaluation method is for the group "ICT-staff" and the model is based on the properties of a virtual learning application that are needed for installation, maintenance and managing a virtual learning application. The criteria are not based on the learning method. The criteria that are selected for the model are presented in Table 5.9 and are administrative, maintenance, cost-benefit, application maintenance, platform and open source properties. I selected these properties after studying a number of virtual learning applications and discussion with ICT-staff members concerning the property of virtual learning environment and applications. I emphasize that the selection of criteria is partly based on our own expertise of teaching both personally and by using virtual learning applications, and the role of ICT manager in the unit.

Table 5.9 ICT- staff's evaluation objects for the evaluation method

Evaluation preference (object/property)	***Description***	***Variable in the model***
Administrative	Ability to use LDAP protocol and communicate with Directory (eDir or Active Directory)	vlacit1
Environment maintenance	How easy is it to install and maintain selected virtual learning applications in the infrastructure.	vlacit2
Cost-benefit	Installation and maintenance costs compared to calculated benefits.	vlacit3
Application maintenance	How easy is it to organize needed changes and updates for the virtual learning application.	vlacit4
Platforms	Ability to install and maintain different platforms selected for the virtual learning application (Unix/Linux, Windows, Mainframe).	vlacit5
Open source	Preferences of open source or commercial application is also important for IT-staff, since the technical expertise and knowledge, how virtual learning applications can be maintained and managed depends on suppliers knowledge and knowing.	vlacit6

$$ICTEM_j = \sum_{r=1}^{n} w_r * vlacit_{rj},$$

where w is the weight of $criterion_r$, and $vlacit_{rj}$ an evaluation criterion for the virtual learning application based on the needs of ICT-staff.

5.6.4 Stakenholder group executives

The fourth evaluator group is "executives", since the members of the executive group are in many cases the final decision maker. In reality, the final decision can be made by one executive, and this is a typical situation in many public organization. When concerning roles of executives in an evaluation, then the question arises of how to link an organization's vision and mission and apply the learning methodology to the evaluation process. I point out that the role of executive is to link the organization strategy to the evaluation process. Therefore, it is useful to derive evaluation criteria from vision and mission, and I present an assumption that the executive's decision-making is based on the role of decision maker as described in Chapter 4. The evaluation method of Executive (EXEM) is identified in Table 5.10, where the evaluation objects/properties are defined by using organization vision, mission, supplier reputation, learning method, application cost-benefit, platform and open source properties. The defined properties and requirements are included in the evaluation method, since I believe executives should base decisions on rational reasons and thinking about how a decision will have an impact in the long run for vision and mission and how an organization is operating. I point out that Hallikainen and Chen (2006) defined strategic value for evaluation criteria. However, I argue that these are too general to use as evaluation criteria, since I derive specified evaluation criterion.

Gronholm and Goldkuhl (2003a/b) defined strategic benefit, which I denote in our evaluation method by using vision and mission. Supplier reputation is identified to be an important property when selecting suppliers according to Keil and Tiwana (2006). The cost and benefits are from the economical point of view a very important matter and executives should evaluate and compare these to other criteria. It is suggested that calculating costs and benefits directly is not the best way to evaluate an information system. Therefore, the actual cost and benefit calculations are not included in the evaluation methods, since these variables are observed in other studies to affect an evaluation process in a way that other variables are not evaluated properly. The platform property is included, since it denotes a general IT infrastructure in the organization. The open source application or commercial application is a property that needs to be taken into account in public organizations today.

Table 5.10 Executive's evaluation objects for the evaluation method

Evaluation preference (object/property)		*Variable in the model*
Vision/Mission	Able to use LDAP protocol and communicate with Directories (eDir or Active Directory)	vlace1
Supplier reputation	The executives should decide how to evaluate the role of suppliers and expertise and knowledge and know how.	vlace2
Learning method	The executives should decide how important it is to take into account learning methods that are applied in the organisation and its units, when units are using different learning methods.	vlace3
Application cost-benefit	Installation and maintenance costs compared to calculated benefits. How easy is it is to organize needed changes and updates for virtual learning applications.	vlace4
Platforms	Able to installation and maintain different platforms for the selected virtual learning application (Unix/Linux, Windows, Mainframe).	vlace5
Open source	The executives should decide how to choose between open source and commercial applications.	vlace6

$$EXEM = \sum_{r=1}^{n} w_r * vlace_{tj},$$

where w is the weight of $criterion_t$ and $vlace_{rj}$ denotes a score of the virtual learning application $_j$.

5.6.5 Summary of stakeholders evaluation preferences

The developed evaluation methods for a virtual learning application can be divided into ex-ante, ongoing and ex-post versions. These versions are described in Table 5.11, which includes evaluation preferences (objects), the defined variables from the students', teachers', ICT-staff and executives' evaluation methods. The purpose to represent the defined variables in Table 5.11 is to show that the developed evaluation methods can be used for ex-ante, ongoing and ex-post evaluation, even the main objective of this study is to develop an ex-ante evaluation method. Variables that can be used ex-ante, ongoing and ex-post version is marked by using letter X. The selection of the variables for ex-ante, ongoing and ex-post versions are carried out by using the importance of the variable in an evaluation process.

Table 5.11 Summary of evaluation objectives for a virtual learning application

Evaluation object	*Variable*	*Ex-ante version*	*Ongoing version*	*Ex-post version*
Student's evaluation method				
Login/Logoff	vlacs1	X	X	X
Asynchronous discussion (chat)	vlacs2	X	X	X
Synchronous discussion forum	vlacs3	X	X	X
File handling	vlacs4	X	X	X
Writing files	vlacs5	X	X	X
Reading files	vlacs6	X	X	X
Viewing files	vlacs7	X	X	X
Searching files	vlacs8	X	X	X
Questioning	vlacs9	X	X	X
Reflection and evaluation	vlacs10	X	X	X
Teacher's evaluation method				
Login/Logoff	vlact1	X	X	X
Course content	vlact2	X	X	X
File handling	vlact3	X	X	X
Asynchronous discussion (chat)	vlact4	X	X	X
Synchronous discussion	vlact5	X	X	X
Writing	vlact6	X	X	X
Reading	vlact7	X	X	X
Viewing	vlact8	X	X	X
Searching	vlact9	X	X	X
Questioning	vlact10	X	X	X
Testing	vlact11	X	X	X
Reflection and evaluation	vlact12	X	X	X
ICT-staff's evaluation method				
Administrative	vlacit1	X	X	X
Environment maintenance	vlacit2	X	X	X
Cost-benefit	vlacit3	X	X	X
Application maintenance	vlacit4	X	X	X
Platforms	vlacit5	X	X	X
Open source	vlacit6	X	X	X
Executives' evaluation method				
Vision/Mission	vlace1	X	X	X
Supplier reputation	vlace2	X	X	X
Learning method	vlace3	X	X	
Application cost-benefit	vlace4	X	X	X
Platforms	vlace5	X	X	X
Open source	vlace6	X	X	X

The identification of the ex-ante, ongoing and ex-post evaluation versions points out the situation that the evaluation should be carried out before purchase or before the start of the

development project, if using an in-house application. The ongoing evaluation should be carried out at least once, when the virtual application is in an active use. The ex-post evaluation is seldom carried out; even many evaluation handbooks include suggestions to do it regularly. However, I stress that the ex-post evaluation should be carried out, when it is planned to remove application from the active use.

5.7 Summary

The collaborative problem based learning (CPBL) is identified and presented in Section 5.3 and an evaluation method of a virtual learning application based on the collaborative problem based learning is created in Section 5.5. The evaluation method of a virtual learning application called the collaborative problem based learning evaluation (CPBLE) is the contribution of this study. The definitions of the criteria in the CPBLEM are derived from the SOLO taxonomy and the collaborative problem based learning method, so I can emphasize that the educational method is included in our evaluation methods. The evaluation objects of CPBLE-model are used to create a students' evaluation method of a virtual learning application and to develop a teachers' evaluation method of a virtual learning application. The students' evaluation method and teachers' evaluation method are described in Section 5.6. The 'group of ICT-staff' and 'executives' evaluation methods are identified by using the properties of a virtual learning application, maintenance processes and maintenance properties. The evaluation method for a virtual learning application for the 'executives' includes suppliers' reputation. Therefore, that this was identified as an important property in other studies (c.f. Keil and Tiwana, 2006 and Hallikainen and Chen, 2006).

By summarizing the defined evaluation methods, I use the developed formulas in Section 5.6, which are represented in the evaluation method for a virtual learning application for each stakeholder group starting from 'students' and ending with 'executives':

$$SUEM_j = \sum_{i=1}^{n} w_i * vlacs_{ij},$$

$$TUEM_j = \sum_{i=1}^{n} w_i * vlact_{ij},$$

$$ICTEM_j = \sum_{r=1}^{n} w_r * vlacit_{rj},$$

$$EXEM_j = \sum_{r=1}^{n} w_r * vlace_{rj},$$

I combine the developed evaluation methods for a virtual learning evaluation application by using the following formula, which includes the above presented models and I define an evaluation method for a virtual learning application (VLEM):

$$VLEM = \sum_{r=1}^{4}\left(g_1 \sum_{i=1}^{n} w_{i*} vlacs_{ij} + g_2 \sum_{i=1}^{n} w_{i*} vlact_{ij} + g_3 \sum_{r=1}^{n} w_t * vlacit_{rj} + g_4 \sum_{r=1}^{n} w_r * vlacer_{rj}\right), \text{ where}$$

The weight value w_i is calculated by using the AHP method and powered by using the second order matrix to weight values, which are summarized and converted to the eigenvalues, which are used to produce a rank value of a virtual learning application. The group weight value can be derived by estimating each stakeholder group's importance in the evaluation process. If I assume that each group is equally important, then group weight value become 1, and I simplify evaluation metrics.

I propose that the identified evaluation criteria are usable for ex-ante, ongoing and ex-post evaluation in general meaning in all evaluation alternatives. However, some of the criteria are only valid for ongoing and ex-post evaluation. Different versions of the evaluation methods are presented in Table 5.11. By using Table 5.11, I point out that the developed evaluation methods are usable for a different evaluation situation: *ex-ante, ongoing and ex-post evaluation*. The criteria for an ex-ante evaluation method for the test are identified and selected in Section 6.4, when the evaluation methods are combined with the used the AHP method, and demonstarions are carried out.

The defined virtual learning environment and evaluation process model is utilized in this chapter. The defined criteria of students, teachers, ICT-staff and executives are derived by using the requirements of stakeholder groups and investigated properties of virtual learning environment, which is specified by applying the collaborative problem based learning method. An ideal virtual learning application and its attributes (properties) are derived based on an individual learning process and practices of knowledge processes, which were identified by Orlikowski and Lund Snis. A dialogue is applied. Therefore, a collaborative problem based learning method includes discussion sessions and according to Laurillard, Aarnio and Enqvist, a dialogue is essential in knowledge creating processes in higher education.

Chapter six

6 The Demonstrating evaluation method and metrics

6.1 Introduction

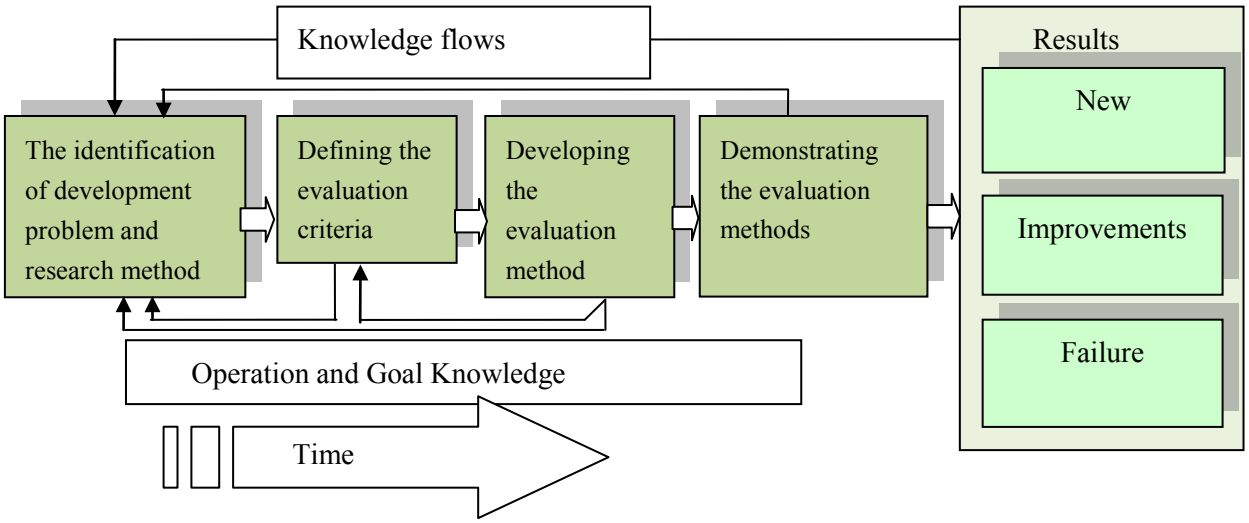

Figure 6.1 The structure of evaluation demonstration stage

Chapter 6 is organized into six sections, and I am initially going to describe the structure and aim of this chapter. The main aim is to demonstrate the developed evaluation method and use the AHP method to calculate a criterion value for each criterion and for the selected stakeholder group. The selected virtual learning applications are evaluated using the defined criteria. The calculation is carried out by using an Excel workbook. The workbook is organized into worksheets and an individual worksheet is used for each stakeholder group; summarized values of the criteria are consolidated into the workbook's 'total' worksheet.

The case study and the selected virtual learning applications will be analyzed by using the virtual learning application evaluation methods, which were developed in Section 5.6 . The case environment is one polytechnic or university of applied sciences in Finland, a singular higher educational institution in Finland. The term 'further education', which denotes an education that is arranged and after the secondary school, and polytechnics offer higher education for adults. The stakeholder group 'students' are divided to undergraduate and adult learners. When considering an evaluation situation and possible evaluators of the student group, it should be aware that undergraduate learners prefer different things than adult learners of the student group.

In Section 6.2, the selected virtual learning application, as these are called in this study, are described and briefly presented. The selected virtual learning applications are:

a) Blackboard,
b) Discendum Optima,
c) Future Learning Environment,
d) Moodle, and
e) WebCT

Among the selected ones are two commercial applications, two open source applications and an Application Service Provider (ASP) application. The term 'Application Service Provision' is also used when ASP companies are describing their service with online usually via the Internet. I point out that these applications represent all types of acquiring alternatives, since there are licensed versions (Blackboard and WebCT), open source licensed versions and an ASP version. Therefore, the decision makers can take into account three types of acquiring alternatives.

The Stakeholders' roles in a decision-making process are described and defined in Section6.3. The defined stakeholder groups are:

a) *executives,*
b) ICT-staff
b) teachers and,
c) students.

The main idea of using four stakeholder groups is to show that each group has its own types of criteria, which have to be taken into account during the evaluation process the stakeholders' role before the decision-making. I point out that, in reality, the roles of ICT-staff, teachers, and students may only have to carry out the evaluation process, and the final decision-maker is a member of the executives.

In Section 6.4, the results of evaluation methods and the results of the evaluation are presented and analyzed and the calculations of the evaluation methods are carried out by using the AHP method. The ex-ante evaluation method for virtual learning for stakeholders groups is described and the evaluation results of each evaluator's group are shown in this Section. The individual worksheets of each stakeholder group are included in Appendix 1.

In Section 6.5, I present the main results of the demonstration process. Students' evaluation method, teachers', ICT-staff's, and executives' evaluation method for a virtual learnining are demonstrated and each group's main results are analyzed.

6.2 Presentation of the case study

As a case study was selected for research method, it means that to carry out an analysis it is necessary to select a limited number of virtual learning applications so that the test of the developed evaluation methods is reliable and valid. There are many virtual learning applications (environment) to select. The most commonly used virtual learning applications' recommendations and marketing messages point out that there are suitable applications for all

kinds of learning purposes. I do not agree at all with those kinds of claims. It should be kept in mind that used or selected learning methodology is one criterion or criteria group. The organization context of this case study is a polytechnic and the learning method is collaborative problem based learning (CPBL) as identified in Chapter 5. These organizational contexts and learning and teaching styles or methods have to be kept in mind when evaluating and selecting virtual learning applications.

The organization is a Finnish university of applied sciences offering education for information technology, media technology, and mechanical engineering students. The number of student is about 1000 and the number of staff about 70. It has been interesting to investigate the chronological decision making processes, because during this research process, the following virtual learning applications have been available and used:

a) Learning Space (Lotus) that was used in one unit,
b) WebCT was the second application that was used between 2000 - 2004,
c) The Business and Administration programme selected their own virtual learning application, Discendum Optima, and it was hired and used based on an ASP-agreement.
d) In 2004, there was a discussion that it should use only one virtual learning application and environment. After discussions, one organization unit made the decision and the selected virtual learning application was Moodle.

One argument for this decision was that this virtual learning application is Open source and there is no need to pay maintenance or a user account fee outside the organization, and that local Moodle support is available. To my knowledge, no calculations about the unit's own administrative personal costs and local support costs were made or presented. As a brief description of the selections, a process of virtual learning application may be quite typical in many learning organizations as described in Chapter 2. I point out, that a decision is made using only one or two criteria and these are evaluated using a subjective appraisal method. All the stakeholders are not included in this decision making process. After implementation, for example it can be possible for students and teachers to give their own appraisals for that selected virtual learning application.

6.3 Presentation of stakeholders

The stakeholders and evaluation levels that should be taken into account when developing an evaluation method of virtual learning application and the effort to achieve commitment for the stakeholders groups is presented in Figure 6.2. The following types of stakeholders and stakeholders groups are identified:

The group of 'executives', which includes Headmasters, Dean and directors,
The group of 'teachers', which includes processors, lectures and teachers,
The group of 'ICT-staff' includes IT-managers and developers,
The group of 'students' includes undergraduate and adults.

The identified groups are the same as they were used, when it was developed an evaluation method for a virtual learning application in Chapter 5. The levels of the organization are identified by using the structure, which was presented in Chapter 3.

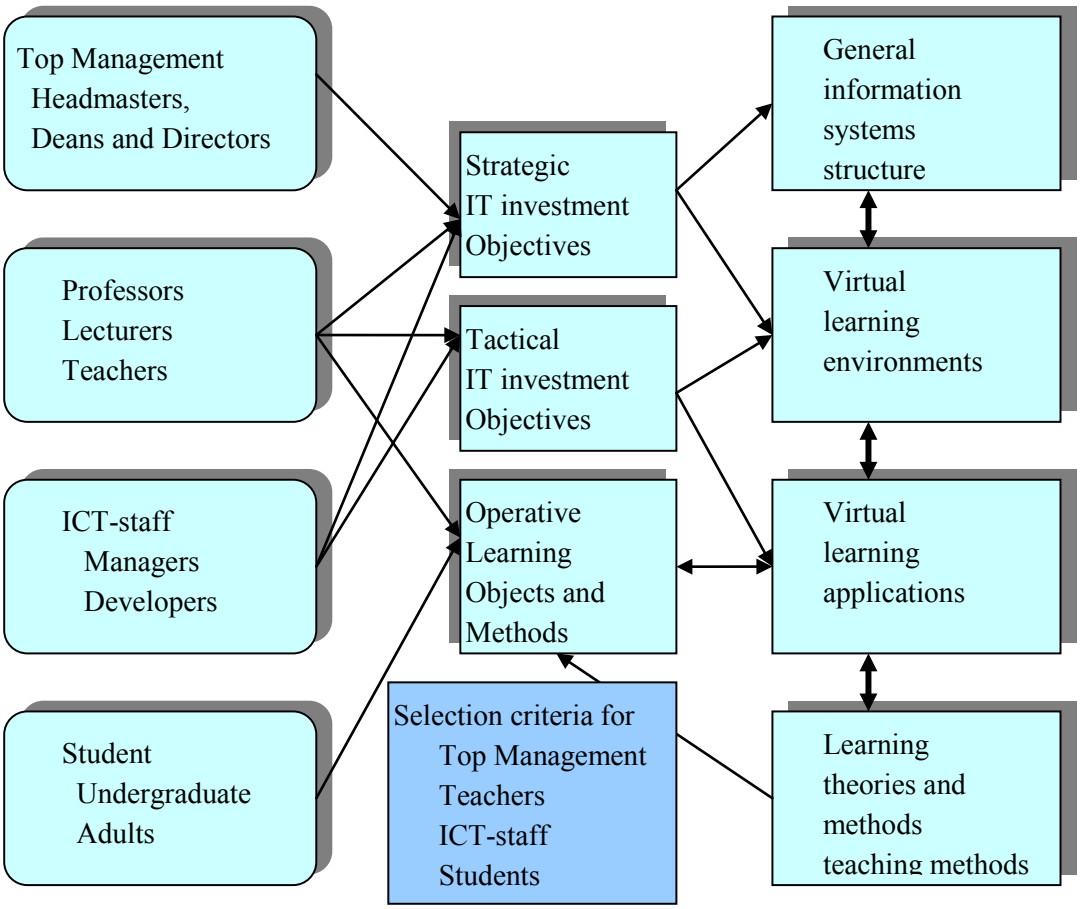

Figure 6.2 The stakeholders and evaluation levels of virtual learning applications

The structure of the information system is identified by using the following concepts:

1. 'General information systems' structure includes hardware, operating software and local and mobile network,
2. 'Virtual learning environments' consist of learning management systems, content management systems and content producing systems,
3. 'Virtual learning applications' represent the selected virtual learning application(s),
4. 'Learning theories and methods and teaching methods' represent the selected learning method, which is the collaborative problem based learning method.

It is assumed that the identified objectives, learning and teaching methods affect each other, and the decision makers and the users of virtual learning applications as evaluators should take into account the defined objectives. The arrows in the figure denote the relationships between the participants and the identified components in the described decision making situation. It is suggested that the decision-making situation is complex and it can affect an evaluation process

and especially in the decision-making situation, which is described in Figure 6.2. The Multiple-decision making method means that evaluation methods include strategic, tactical, and operational evaluation criteria. These evaluation criteria are integrated to the holistic evaluation method, and models and criteria are developed from hierarchical tree like properties structure. Analyzing each group of stakeholders and their roles and meaning in the evaluation processes mean that criteria may and in reality mean different things to each group of stakeholders. What is also taken into account, is that even a member of a group of stakeholders can and may think differently and create their own meaning for each criteria, as DeRuyter (1995) has pointed out: **"While it is reasonable to assume that each stakeholder desires a successful outcome, it is unreasonable to assume that each stakeholder desires the same outcome."**

So it is necessary to try to develop a usable and applicable taxonomy of decision-makers roles and define these roles against the evaluation processes and the desired outcomes. One approach is to analyze a general type of decision-making process and differentiate the decision-makers role. During an evaluation processes each evaluator is assumed to be a member of their own group. The evaluator makes judgments on each criterion by making pairwise comparisons of the alternatives.

6.4 Presentation of alternative virtual learning applications

The selected virtual learning applications are presented in Table 6.1 and each of these applications is described in this section. A researcher makes the selection and the main stipulation for each application is that the researcher has used them or that he orshe has at least some experience each one. Evaluating an application in the proper way demands that an evaluator knows the object and can carry out an evaluation correctly. This argument is crucial for the developing reason. The researcher is then capable of creating an evaluation method or models. Using evaluation methods after developing a process does not require a deeper knowledge of each application but it helps quite a lot in evaluating.

Table 6.1 Selected virtual learning applications for evaluation

Name of VLA	Learning methodology	Licence types	Platform	Company
Blackboard: 1. Learning System 2. Learning System ML 3. Portal System 4. Content system (Academic Suite)	Course management system Student portal Course material management	Commercial	Web/Application server (4 processors) Database server (4 processors) Servers: Solaris 8 or newer Windows 2000 or newer Databases: Microsoft SQL Server 2000 Microsoft Internet information 5	Blackboard Inc.

Discendum Optima	Project learning Workshop learning	Commercial active and passive user fee/year	Application Service Provider (ASP)	Discendum Oy
Future Learning Environment	Knowledge building Collaborative learning	F/OSS	Linux servers Unix servers Apache ZOPE Python	UIAH Media Lab, University Art and Design Helsinki and Department of Psychology, University of Helsinki.
Moodle	Constructivism Social Constructivism Connected and separate.	F/OSS	Linux servers Apache MySQL PHP	Moodle.org Moodle.com (Martin Dougiamas)
WebCT		Commercial versions: Campus and Vista, which is an enterprise version.		Blackboard Inc. WebCT.com

6.4.1 Blackboard Learning Applications

Blackboard, current version 6, includes different versions, Academic and Commercial Suites. The Academic Suite includes a Bb Learning System, a Content System, and a Portal System. The Commercial Suite includes a Bb Transaction System, Bb One, and a Portal System. For evaluation purposes, Academic Suite and its component the Bb Learning System, Content System, and Portal System build one virtual learning system that can be evaluated by using developed evaluation criteria. The next version, 7.0 has been released under the Academic Suite. The Blackboard Learning System is possible to test by using 60 days free offer from Blackboard.com and the testing organization can create their test course. For evaluation purposes, one course is created on the Blackboard server and Learning System's properties were tested. For testing environment, one course was used and that course was Java programming for Mobile Applications. A good description from the educational point of view can be found in the final report of Britain and Liber (2006, pp. 35-38).

Britain and Liber provide a comment at the end of the description saying: "A variety of themes emerged from this interview. Where teaching and learning interactions are concerned, the responses to our questions suggest that the system has now become sufficiently flexible to handle a wide range of workflow models and that courses could be structured in a discussion-

oriented or resource-based manner if desired. However, in common with webCT, the typical mode in which Blackboard is used is to support a content-based, essentially transmission model as that is the dominant mode of education."

The view expressed by Blackboard in our interview was that it was the role of their systems to provide the generic tools and overall framework to support e-learning but not to try and provide the distinctive pedagogical tools that are particular to different contexts – the variety is too great for a single organisation. Their solution is to open-up Java APIs through their Building Blocks programme to encourage 3rd party developers to create those tools."

A test case, to use and evaluate Blackboard as a tool with the collaborative problem based learning method, was organized for us during the visit in Australia. A discussion forum was arranged so that I were able to chat, send and receive messages. This short test session revealed that discussions need an experienced group tutor, which can guide discussion and can send questions concerning the learning object. However, one conclusion was that Blackboard might not be flexible enough to utilize for collaborative problem based learning sessions.

6.4.2 Discendum Optima

Discendum Optima is a Learning Application that the Application Service Provider (Discendum Oy) offers to schools, polytechnics and universities. As an application user students and teachers use the application via web browsers. The ASP Company offers servers and the hiring of disc space for a one-year fee on agreement, which is based on the numbers of users, which in turn is divided into non-active and active users. The fee is different for non-active and active users, and the calculation is carried out monthly.

Discendum Optima was used during 2002 – 2005 quite effectively in degree programme marketing as a virtual learning application. The main objective to select Discendum Optima was a typical one. A single teacher, who was responsible for one research project decided to select Discendum Optima for testing purposes, and she explained she liked the application. When asking for more reasons why Discendum Optima was better than others, there were no objective or logical reasons. This short description of the selection process is an example that the objective and logical requirements may be difficult to define. For example, the learning method and the criteria derived from the learning method were not created. Discendum Optima and its properties have been investigated and developed continuously according to information at the user meeting in April 2009. The current version includes the following features:

1. Web services interface for transfer data between other applications.
2. Single Sign-On tools
3. New version for Admin tools
4. Role management for course users
5. New forms and tools for data management
6. Messaging function updated.
7. Process writing tools (collaborative writing)

8. Feedback boxes updated
9. A course assessment tool updated and transfer tool for Excel formats included.

However, the above listed features are not included in the evaluation method in this study. Features are added, since the current version is different from the demonstrated version.

6.4.3 Future Learning Environment (FLE3)

FLE is an Open Source licensed application. It available from the developer's server. The Platform can be Linux, UNIX, Mac, and Windows. However, the installation instruction is written for Linux, which is the recommended platform. On the server, you have to have a ZOPE database and Python compiler, since the application is developed by using Python script language. Future Learning Environment releases are published under the GPL Licence. The tested version release 2, but current version 3 is reviewed and evaluated. FLE consists of three tools that are called FLE WebTobs, Knowledge Building, and Jamming Tools. The Administration tools are available for teachers and administrators.

A singe test session was arranged and teachers of the degree programme marketing were piloting it during one session. The test session revealed that effective use of FLE needs experienced tutors and teachers who have to learn how to use the application and utilize properties of FLE and how to use different tools before it can be installed for learners to use. After test session, teachers were asking about terminology of FLE3, what these unknown terms are, and why these were used. Teachers asked how different tools are utilized in a real life learning sessions if ICT staff or experienced tutors are not available, when problems arise during learning sessions.

The learning method that is utilized, when FLE application is developed is defined as a project or research learning method and in order to understand defined name of tools it is necessary understand learning method and its philosophy. By comparing project or research learning method and collaborative problem based learning method it can be point out that both include similar learning processes. Collaborative knowledge building is a central concept in FLE, and arguments, which are presented, stress the active role of the learner; learner is responsible for the learning processes, the learner solves problems utilizing artists and researchers working methods.

6.4.4 Moodle

The Modular Object-Oriented Dynamic Learning Environment (Moodle) consists of a MySQL database and PHP scripts. It is necessary to have at least one Linux based server, and an Apache web-server if the system is to be self-administrated. It is possible to hire a course base and administration at some ASP companies too. Moodle’s current version is 1.7. It is an Open Source version and the developer’s work is organized in the moodle.org community; the

commercial version and support can be obtained from moodle.com. The description of Moodle argues that educational philosophy is social constructivism. Britain and Liber (2006, p.56) described Moodle in the the following way: "It is designed from a constructivist perspective and has a number of specifically constructivist tools e.g. reflective journals, peer group assessments, the ability to rate posts on a dimension which represents the level of connected vs. separate knowing demonstrated by the poster. It is designed to be modular and developers are encouraged and supported in developing new activity modules to complement the ones provided as standard with the system. Information about people is important in Moodle and a users profile including their photo appears where ever their name appears." The Open source application Moodle is analyzed and evaluated by Britain and Liber (2006). They pointed out that a problem still exists, when they analysed the properties of Moodle. They stated that "The optimism surrounding open-standards and the development of common frameworks for e-learning has to be tempered by the understanding that there remain difficult technical and organisational problems with both the transport and reuse of learning activities at the e-learning level and the top-down approach involving the specification of educational interoperability standards that meet needs across the industry." They continued by saying: "The identification of common architectures for core services is one thing, but producing an open framework that can accommodate the interactions and fine granularity components at the level of educational applications has not yet been addressed. While this approach offers considerable hope for the future there is a long journey still ahead." I agree with Britan and Liber's comments, and I emphasize that problems still exist in 2011. However, this open source virtual learning application is used in many learning organizations nowadays.

6.4.5 WebCT

At the current time, Blackboard has purchased WebCT Learning System and according to the announcement in February 2005, they will continue to keep Blackboard and WebCT as separate brands, but over time, they will incorporate both products into a new product by using user feedback on the best features and usability. In that context, selecting WebCT as one of the evaluated applications is, from the current situation not so interesting. WebCT has two products: the Campus version, which is a course management system, and the Vista version, which is an enterprise system, and it is completely re-built and coded by using J2EE 3-trier approach. The evaluated version is the Campus version.

Britain and Liber (2006, pp. 31 – 34) state that "Positioned as an Academic Enterprise System, the main benefits of Vista over and above the Campus product are at the level of the support for institutional and cross-institutional level management of degree programmes and support for student management of their own learning as indicated by the responses above. Monitoring is still based on tracking facilities of debatable information value. Student self-organisation is limited in that they cannot set up their own groups, although they can self-subscribe to those created by lecturers. Also profiling information is limited because of privacy issues. Although it is collected within the system, it is not made available."

6.5 An ex-ante evaluation method for a virtual learning application

The developed evaluation methods for a virtual learning application, which were developed in Section 5.6, are described with the following formulas:

$$SUEM_j = \sum_{i=1}^{n} w_i * vlacs_{ij},$$

$$TUEM_j = \sum_{i=1}^{n} w_i * vlact_{ij},$$

$$ICTEM_j = \sum_{t=1}^{n} w_r * vlacit_{rj},$$

$$EEM = \sum_{r=1}^{n} w_r * vlacer_j,$$

The combined evaluation method for a virtual learning application (VLEM) was defined by using the following formula:

$$VLEM = \sum_{r=1}^{4} (gw_1 \sum_{i=1}^{n} w_i * vlacs_{ij} + gw_2 \sum_{i=1}^{n} w_i * vlact_{ij} + gw_3 \sum_{r=1}^{n} w_r * vlacit_{tj} + gw_4 \sum_{r=1}^{n} w_r * vlace_{rj}), \text{ where}$$

$gw_1,...,gw_4$ are group weight coefficient, if I assume that each group has equal weight in an evaluation process, then $gw_1 = gw_2 = gw_3 = gw_4 = 1$, and the formula can be simplified by removing group weight coefficient.

By selecting the evaluation criteria for the demonstration, I carried out the pre-test to check which evaluation criterion is worth selecting for the ex-ante evaluation method for virtual learning for students, teachers, IT-staff and executives. If the evaluation criterion was valued by using value 1, which means in AHP-method 'equally important' in evaluation scale, then the criterion was not selected for the ex-ante evaluation methods, since it does not differentiate virtual learning applications. I stress that this does not mean that the next evaluation process can be arranged by using the same evaluation criteria, which were selected in the demonstation case, therefore, another evaluator can select different criteria in the pre-test. However, by using the AHP-method, it is possible to select a suitable evaluation criterion, which gets a rank value that can be used to differentiate applications.

The evaluation method for a virtual learning application for students includes the following evaluation criteria:

Network login (login/logoff in Table 5.8),
Chat (Asynchronous and synchronous discussion),
File handling,
Group writing and
Reflection

The evaluation method for a virtual learning for teachers includes the following evaluation criteria:

Network login,
Chat,
Discussion (Synchronous discussion forum),
File handling,
Reflection and
Quizzes

The evaluation method for a virtual learning application for ICT-staff includes the following evaluation criteria:

Administrative properties,
Managerial properties,
Application cost-benefit properties,
Application maintenance properties,
Platform properties (requirements) and
Open source licensed application

The evaluation method for a virtual learning application for executives includes the following evaluation criteria:

Vision/Mission,
Supplier reputation,
Learning method (Learning methodology),
Application cost-benefit properties,
Platform properties (requirements) and
Open source licensed application

The purpose to limit the number of the evaluation criteria of the evaluation method for a virtual learning application was to build a test case, so that the developed evaluation methods are possible to demonstrate by using the evaluation criteria, which are the most important for the evaluation process. In this way I were able to build a simple evaluation method for the test, so that I were able to carry out test calculation by using a single Excel worksheet for each stakeholder group.

6.6 The main results of evaluation methods

The evaluation method for a virtual learning application for students is applied by using the AHP method and the results are represented in the Excel worksheets, which are included in Appendix 4. The values of evaluation criteria and the matrix of the evaluation criteria are described in Table 6.2, in which the evaluated values are created by using the AHP

measurement scale using values from one to nine. The right part of the matrix is filled by using the inverse values of the left part of the matrix. For example by comparing Network login and File handling the value is 1/3 = 0,33 in the first raw, when the value of the first column is 3, so the criterion File handling is evaluated by using the value "moderately important" compared to Network login.

Table 6.2 The students' values of evaluation criteria

Evaluation criterion	Nl	Ch	Di	Fh	Gw	Re
Network login (Nl)	1,00	0,20	0,20	0,33	0,20	0,33
Chat (Ch)	5,00	1,00	0,20	0,33	0,20	0,33
Discussion (Di)	5,00	5,00	1,00	1,00	0,20	0,33
File handling (Fh)	3,00	3,00	1,00	1,00	0,20	0,33
Group writing (Gw)	5,00	5,00	5,00	5,00	1,00	0,33
Reflection (Re)	3,00	3,00	3,00	3,00	3,00	1,00

Even in the evaluation the object matrix included more than six criteria, the final matrix consists of the criteria, which revealed to be the important criteria. It is good to know that if two criteria are equally validated, then we can remove these criteria from the final evaluation matrix.

Table 6.3 The matrix of the evaluation criteria

Evaluation criterion	Square matrix						Row Sum	Eigen value	CI	CI/RI	CI/RI
Network login	6,00	4,40	2,77	2,93	1,55	0,98	18,63	0,03	0,285	8,219	
Chat	14,00	6,00	3,73	4,53	2,51	2,58	33,35	0,06	0,473	7,626	
Discussion	40,00	16,00	6,00	7,33	3,60	4,40	77,33	0,14	0,909	6,320	
File handling	28,00	13,60	5,20	6,00	2,80	3,07	58,67	0,11	0,715	6,558	
Group writing	76,00	52,00	18,00	19,33	6,00	7,33	178,67	0,33	2,186	6,580	
Reflection	60,00	45,60	25,20	26,00	8,40	6,00	171,20	0,32	2,363	7,425	
Total							537,85	1,00		7,121	
										0,224	0,181

The decision matrix is represented in Table 6.4, which reveals that the recommended choice is the Future Learning Environment, and the second is the Discendum Optima, when the order is carried out by using the rank values.

Table 6.4 The students' decision matrix of the virtual learning appilication

A virtual learning application	Cr*	Rank value	Rank
Blackboard (BB)	0,03	0,09	4
Future Learning Environment (FLE)	**0,06**	**0,38**	**1**
Discendum Optima (DO)	0,14	0,25	2
Learning Space (Lotus) (LS)	0,11	0,06	5
Moodle (M)	0,33	0,16	3
WebCT (WCT)	0,32	0,06	6
Total	1,00	1,000	
*Criterion ranking = Cr			
Students' Inconsistency ratio	0,088		

The Students' consistence ratio 0,089 is an average value of calculation by using the value of consistence index divided by Saaty's (2006, p.84) Random Consistence Index (RI) value, which is 1.25, when the number of criteria is 6. According to Saaty (2006, p. 84-85) the average values should be around 10%.

The evaluated values of the selected criterion of the evaluation method for a virtual learning application for teachers are represented in Table 6.5.

Table 6.5 The teachers' values of the evaluation criteria

An evaluation criterion	Nl	Ch	Di	Fh	Re	Qu
Network login (Nl)	1,00	0,20	0,20	0,20	0,33	0,33
Chat (Ch)	5,00	1,00	0,33	0,33	0,20	0,20
Discussion (Di)	5,00	3,00	1,00	0,20	0,20	0,20
File handling (Fh)	5,00	3,00	5,00	1,00	0,20	0,20
Reflection (Re)	3,00	5,00	5,00	5,00	1,00	0,33
Quizzes (Qu)	3,00	5,00	5,00	5,00	3,00	1,00

The matrix of the evaluated values is calculated in Table 6.6, which includes the matrix calculation and the eigenvalue of the criterion and the teachers' inconsistency value 0,249.

Table 6.6 The Teachers' matrix of the evaluated values

An evaluation criterion	Square matrix						Row Sum	Eigen value	CI	CI/RI
Network login (Nl)	6,00	4,93	4,80	3,84	1,79	0,90	22,26	0,03	0,317	9,171
Chat (Ch)	14,53	6,00	5,33	3,73	2,80	2,27	34,67	0,05	0,441	8,201
Discussion (Di)	27,20	9,60	6,00	4,40	3,31	2,77	53,28	0,08	0,583	7,046
File handling (Fh)	51,20	24,00	14,00	6,00	4,27	3,73	103,20	0,16	1,041	6,503
Reflection (Re)	82,00	42,27	38,93	14,93	6,00	4,67	188,80	0,29	2,005	6,843
Quizzes (Qu)	90,00	55,60	52,27	28,27	10,00	6,00	242,13	0,38	2,842	7,562
Total							644,34	1,00		7,554
										0,311

The decision matrix of the evaluation method for teachers is calculated by using the selected criterion and the evaluated virtual learning applications. This matrix shows that the best choice is Discendum Optima, when the evaluation is carried out by using the teachers' evaluation criteria.

Table 6.7 The teachers' decision matrix of the virtual learning application

A virtual learning application	Cr	Rank value	Rank
Blackboard (BB)	0,03	0,14	3
Future Learning Environment (FLE)	0,05	0,25	2
Discendum Optima (DO)	**0,08**	**0,37**	**1**
Learning Space (Lotus) (LS)	0,16	0,05	6
Moodle (M)	0,29	0,11	4
WebCT (WCT)	0,38	0,09	4
Total	1,00	1,000	
Criterion ranking = Cr			
Teachers' Inconsistence ratio	0,157		

The average value is 0,157, which is calculated by using the inconsistency values of the selected criterion.

The results of the ICT-staff's evaluation method for the virtual learning application are calculated using the selected criteria, which are represented in Table 6.8. The name of the selected criterion is specified that maintenance properties can be differentiated from each other. The maintenance properties denote the work of a virtual learning environment and the application maintenance properties are specified to a work of a virtual learning application.

Table 6.8 The ICT-staff's decision matrix of the evaluation critera

ICT staff	Ap	Mp	Ac	Am	Pp	Os
Administrative properties (Ap)	1,00	0,33	0,20	0,33	1,00	1,00
Maintenance properties (Mp)	3,00	1,00	3,00	5,00	1,00	1,00
Application cost-benefit properties (Ac)	5,00	0,33	1,00	1,00	1,00	1,00
Application maintenance properties (Am)	3,00	0,20	1,00	1,00	1,00	1,00
Platform properties (Pp)	1,00	1,00	1,00	1,00	1,00	1,00
Open Source (Os)	1,00	1,00	1,00	1,00	1,00	1,00

Table 6.9 The ICT-staff's square matrix of the evaluated values

ICT-staff	Square matrix					
Administrative properties (Ap)	6,00	2,80	3,73	4,53	3,87	3,87
Maintenance properties (Mp)	38,00	6,00	13,60	16,00	14,00	14,00
Application cost-benefit properties (Ac)	16,00	4,53	6,00	7,33	9,33	9,33
Application maintenance properties (Am)	13,60	3,73	5,20	6,00	7,20	7,20
Platform properties (Pp)	14,00	3,87	7,20	9,33	6,00	6,00
Open Sourse (Os)	14,00	3,87	7,20	9,33	6,00	6,00

The eigenvalues of the evaluation criteria for a virtual learning application for ICT-staff are presented in Table 6.10. The square matrix and eigenvalues are presented in different tables for presentation reason.

Table 6.10 The ICT-staff's eigenvalues of the evaluation criteria

ICT-staff	Row	Eigenvalue	CI	CI/RI	
Administrative properties (Ap)	24,80	0,08	0,560	7,108	
Maintenance properties (Mp)	101,60	0,32	2,037	6,310	
Application cost-benefit properties (Ac)	52,53	0,17	1,100	6,589	
Application maintenance properties (Am)	42,93	0,14	0,899	6,591	
Platform properties (Pp)	46,40	0,15	1,000	6,782	
Open Source (Os)	46,40	0,15	1,000	6,782	
Total	314,67	1,00		6,694	
				0,139	0,111

The decision matrix for evaluation method for ICT-staff is represented in Table 6.11, which includes the values of the selected criterion and the rank values of the virtual learning application. The best choice is Discendum Optima and the second choice is the Future Learning Environment, when the rank values are calculated by using the IT staff's evaluation criteria. I point out that the virtual learning application that is hired from Application service provider

does not include a maintenance work, since this work belongs to the Application service provider.

Table 6.11 ICT-staff's decision-matrix of the vIrtual learning application

A virtual learning application	Cr	Rank value	Rank
Blackboard (BB)	0,08	0,20	3
Future Learning Environment (FLE)	0,32	0,23	2
Discendum Optima (DO)	**0,17**	**0,28**	**1**
Learning Space (Lotus) (LS)	0,14	0,05	6
Moodle (M)	0,15	0,15	4
WebCT (WCT)	0,15	0,09	4
Total	1,00	1,000	
Criterion ranking = Cr			
ICT-staff's Inconsistency ratio	0,109		

The evaluated values of the evaluation method for executives are represented in Table 6.10, which includes the following evaluation criterion:

Vision/Mission, which is derived from the vision and mission of the organization,
Supplier reputation, which is included in the evaluation criteria, since this criterion is revealed as important to other researchers., Learning method is included for the reason that evaluators of the executives group should also consider the applied learning method in the organisation, especially when more than one learning method is used for learning and teaching. Application cost-benefit criterion is included, since the comparison of the costs should be evaluated by using the measurement scale of AHP method, but not using the euro as an evaluation value. Platform properties is included in the evaluation method, therefore executive evaluators should also be aware of the information systems and the used platforms. Open source licensed applications are used in public organizations and the evaluators should consider that matter.

Table 6.12 Executive's evaluated values of the selected criterion

An evaluation criterion	ViMi	Sr	Lm	Acb	Pp	Os
Vision/Mission	1,00	0,20	0,33	0,33	3,00	3,00
Supplier reputation	5,00	1,00	0,20	3,00	1,00	1,00
Learning method	3,00	5,00	1,00	5,00	3,00	3,00
Application cost-benefit properties	3,00	3,00	0,20	1,00	1,00	1,00
Platform properties	0,33	1,00	0,33	1,00	1,00	1,00
Open Source	0,33	1,00	0,33	1,00	1,00	1,00

Table 6.13 Executive's square-matrix of the selected criteria

An evalution criterion	Square matrix						Row
Vision/Mission	6,00	9,07	2,77	8,93	10,53	10,53	47,84
Supplier reputation	20,27	14,00	3,33	10,67	21,60	21,60	91,47
Learning method	48,00	31,60	6,00	32,00	28,00	28,00	173,60
Application cost-benefit properties	22,27	9,60	2,67	14,00	15,60	15,60	79,73
Platform properties	10,00	7,73	1,51	7,78	6,00	6,00	39,02
Open Source	10,00	7,73	1,51	7,78	6,00	6,00	39,02
Total							470,68

Table 6.14 Executive's eigenvalues of the selected criteria

An evalution criterion	Eigenvalue	CI	CI/RI	
Vision/Mission	0,10	0,817	8,042	
Supplier reputation	0,19	1,450	7,463	
Learning method	0,37	2,990	8,106	
Application cost-benefit properties	0,17	1,297	7,656	
Platform properties	0,08	0,686	8,279	
Open Source	0,08	0,686	8,279	
Total	1,00		7,971	
			0,394	0,318

Table 6.15 Executive's decision matrix of the virtual learning application

A virtual learning application	Cr	Rank value	Rank
Blackboard (BB)	0,10	0,17	3
Future Learning Environment (FLE)	**0,19**	**0,31**	**1**
Discendum Optima (DO)	0,37	0,22	2
Learning Space (Lotus) (LS)	0,17	0,06	6
Moodle (M)	0,08	0,16	4
WebCT (WCT)	0,08	0,09	5
Total	1,00	1,000	
Executive Consistence ratio (CR)	0,13		

Table 6.16 The rank values of the virtual learning applications

A virtual learning application	Students	Teachers	ICT-staff	Executives	Sum	Rank
Blackboard (BB)	4	3	3	3	13	2
Future Learning Environment (FLE)	**1**	**2**	**2**	**1**	**6**	**1**
Discendum Optima (DO)	**2**	**1**	**1**	**2**	**6**	**1**
Learning Space (Lotus) (LS)	6	6	6	6	24	5
Moodle (M)	3	4	4	4	15	3
WebCT (WCT)	5	5	5	5	20	4
Total					84	

The rank values of the evaluated virtual learning applications are presented in Table 6.16, in which the selected virtual learning applications are in alphabetic order, when the rank values of the evaluators are summarized to the rank value of the virtual learning application. Future Learning Environment and Discendum Optima have achieved the same sum value, when individual rank values are summarized. By using the sum value to arrange the final order, the smallest sum value is ranked as the first recommended application, the second recommended application is Blackboard, and the third is Moodle. By carrying out the demostration, I propose that the developed evaluation methods for a virtual learning application can be used to produce the evaluators' recommendations for the decision makers.

Table 6.17 The Inconsistency Ratios

Inconsistence Ratio of Evaluator group	C1	C2	C3	C4	C5	C6	Average
Students' Inconsistency ratio	0,18	0,00	0,04	0,07	0,18	0,06	0,09
Teachers' Inconsistency ratio	0,25	0,11	0,27	0,10	0,09	0,12	0,16
IT staffs' Inconsistency ratio	0,11	0,19	0,12	0,02	0,08	0,14	0,11
Executive's Inconsistence ratio	0,32	0,05	0,09	0,20	0,03	0,12	0,14

The inconsistency ratios (IR) are calculated dividing the consistency index by random index, which is based on Saaty's calculation in Table 6.17 and these are calculated to average values, which show that the calculated rank values of the virtual learning applications are acceptable, when I use the IR values to measure how reliable, and valid the achieved results are.

Chapter seven

7 Discussion and conclusions

7.1 Discussions

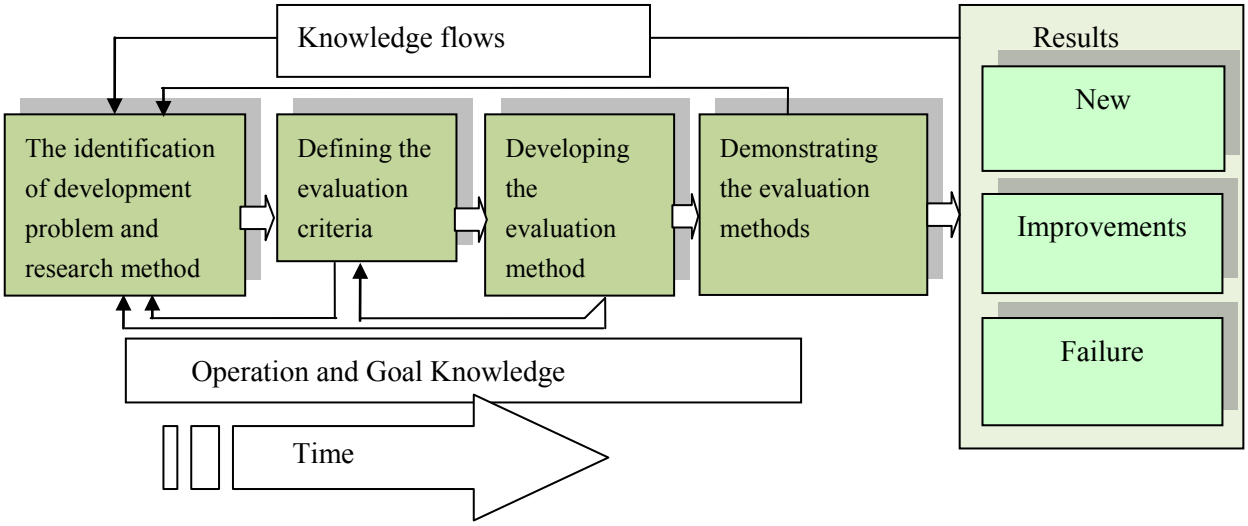

Figure 7.1 The structure of evaluation process stage discussion

In Chapter 7, the achieved results are discussed and the achieved results are compared to the aim of the research. The chapter is organized into four sections. The study process is in its final phase, so the research structure in Figure 7.1 shows the conclusions. In Figure 7.1, the conclusions are divided into the possible effects (results). The structure of design research is used as a process guide in this study, and I propose that Verschuren and Hartog's (2005) general model can be modified for an evaluation study or for developing IT artefacts. I emphasize that the general model needs modification at the real research situation. By following the structure of design research, I suggest the research process can be organized in a systematic way. The main aim of the research was to develop an evaluation method for a virtual learning application. In Chapter one the research questions were defined and the study is carried out by keeping these objective in mind. The research objectives were represented by using research questions:

RQ1: How can be developed a criteria based on a multi-attribute evaluation method and to use AHP methods to calculate evaluation outcomes that an evaluation process of a virtual learning application can be carried out and to produce results that are useful for decision-making?

RQ2: How to demonstrate the collaborative problem based learning evaluation processmodel?

The evaluation method for a virtual learning application was developed by initially defining the first research area and evaluation situation. The virtual learning environment and its

component are presented in Figure 7.2, which was used to specify a virtual learning environment in this study.

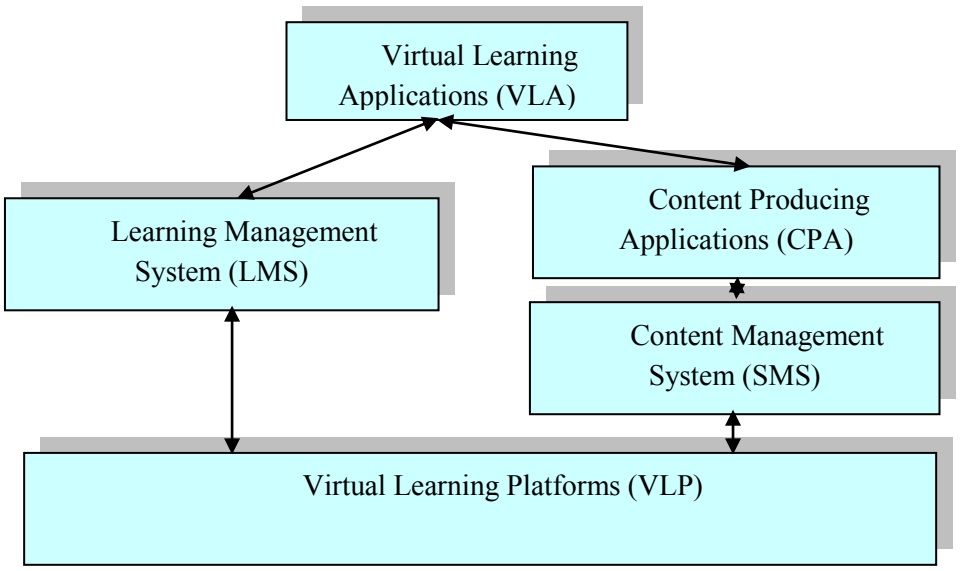

Figure 7.2 The virtual learning environment and its component.

In Figure 7.2, a virtual learning application is defined as a one of the components the virtual learning environment. The purpose of differentiating a virtual learning environment is to separate the study object from the other applications and to find out the essential properties of the virtual learning application without analyzing the other components as a single virtual learning environment. It is also good to recognize that plenty of virtual learning applications can be bought or hired, and Moodle is available for Open source. Learning management systems, Contet management system and content producing applications are as well possible to buy or hire. Virtual learning platforms are normally in use, when organizations are considering virtual learning applications. If we try to organize an evaluation process for the virtual learning environment, it will be difficult and evaluation methods can be very complicated to utilize.

One may ask if a learning method is essential for an evaluation method for virtual learning applications, and the answer is that the learning method is necessary to describe, because the learning situation is realistic and the evaluation criteria can be created using a realistic anyhow.

The learning method and process are identified that it is a collaborative problem based learning process in which students create their knowledge by using facilitators' and tutors' instructions and learning materials for solving problems and creating knowledge and problem solving skills. The concepts 'facilitators' and 'tutors' are included to the teachers' group in this study. These concepts are used in the problem based learning methods to differentiate a role of facilitators, whose role is to arrange learning materials.

The evaluation methods are created by using the collaborative problem based learning method and properties of a virtual learning application. The defined evaluation methods for a virtual learning application for the stakeholder groups are represented by using stakeholder

theory, which is used for identifying the following groups and the developed and analyzed evaluation methods were converted to the following formulas:

Students' evaluation method for a virtual learning application (SUEM),
Teachers' evaluation method for a virtual learning application (TUEM),
ICT-staff's evaluation method for a virtual learning application (ICTEM) and
Executives' evaluation method for a virtual learning application (EEM)

The final evaluation method for a virtual learning application was developed by combining the stakeholders' evaluation methods to the evaluation method for a virtual learning application, which is called as the virtual learning evaluation method (VLEM) it is represented by the following formula:

$$VLEM = \sum_{r=1}^{4}(gw_1 \sum_{i=1}^{n} w_i * vlacs_{ij} + gw_2 \sum_{i=1}^{n} w_i * vlact_{ij} + gw_3 \sum_{r=1}^{n} w_r * vlacict_{rj} + gw_4 \sum_{r=1}^{n} w_r * vlacer_{rj}).$$

The developed evaluation method for a virtual learning application was versioned by using the terms '*ex-ante', 'ongoing' and 'ex-post'* evaluation. The purpose of differentiation was to emphasize that an evaluation process can be arranged in the different stages in the life cycle of a virtual learning application. By developing these versions, I argue that our specification of the evaluation process point out the need of evaluation at a different time and that it is possible that the used evaluation modes can be the same or that the evaluation methods have to be modified before its use.

The identified evaluation methods represent and include identified criteria and the weight values are produced by using the AHP method. In a real situation, it is necessary to limit the number of criterion, so that the selected calculation method will not be too large to carry out a reasonable calculation by using a standard Excel worksheet. Keil and Tiwana(2006) proposed that a real situation, based on their study practitioners' criteria, can be limited and the selection of criteria are possible by using the weighted value of the criterion. I argue that the first reason to limit the evaluation criteria is that an evaluator hit a difficult evaluation problem, if our model includes the number of an evaluation criterion exceed ten, and the other researchers has shown that a human being is able to analyze between five to seven terms at a time. The second reason to limit the evaluation criteria in the evaluation methods was our selection to use the matrix product calculation to produce the rank values for the specified virtual learning applications. The selected calculation method is possible to use, when the evaluation matrixes are square matrixes. However, if we use a geometric average, we can calculate the different number of evaluation criteria, and the calculated values are close to matrix calculation.

By answering to the first research question, I propose that I were able to develop an evaluation method for a virtual learning application using the specified learning method, by applying the stakeholder theory, in which I were able to identify four evaluator groups that are essential, when I am carrying out an evaluation process for a virtual learning application.

The second research question was to show how our evaluation method for a virtual learning application for stakeholder groups is possible to demonstrate by using a standard worksheet calculation and formulas. I claim that I were able to show that by selecting the limited number of the evaluation criterion for evaluation method, the demonstration could be carried out to show the results to be recommended to decision makers. I admit that the demonstration is preliminary. However, it can be carried out by using the same evaluation criteria for the specified evaluation methods, and by selecting different virtual learning applications. The other possibility is to use different evaluation criteria for the specified evaluation methods and to use the same virtual learning applications as were used in this test.

During the discussion with practitioners, and asking why they are seldom utilizing evaluation methods are that the evaluation methods developed by academics and published in scientific journals are not generally aapplicable to practitioners. First, I claim that academic researchers should publish their work for practitioners and participate more in real evaluation projects. In publicly owned organizations, valid and robust evaluation methods are needed, since the competitive bidding and acquiring of projects include that an evaluation method and calculations have to be published beforehand. Possible suppliers can ask evaluation criteria before they send their offers. The second reason may bethat an evaluation situation and the evaluation process is time consuming process and the project leaders has no time to arrange valid evaluation process.

Wohlin and Amcshler Andrews (2003a/b) developed a promising model for information systems projects; they identified the following factors, which are identified as good estimators for successful projects: *a) project plan, b) project plans followed, c) schedule, d) programming practices, e) management performance and f) project team ability.* I propose that identified success factors may help practitioners apply academic evaluation methods, if and when, they can recognize factors that can predict successful projects. These factors can be used as a tool to demonstrate to steering committee, that under the specified resources and needed time schedule, it is possible to achieve promised results and use evaluation methods. Other researchers have asked this question in many times, but reliable answers are not presented only suggestions and proposals.

7.2 Scientific merits

The structure of this study is based on after the literature review, design science framework, which was modified to the structure of evaluation research and this structure is proposed as a usable guide for evaluation projects. By using the Vaishnavi and Kuehler's (2008) general methodology of design science, I propose that the specified structure of evaluation research process demonstrate that the general methodology is useful for applied research process. After the literature review and by defining the concepts for this study, I identified a model for a virtual learning environment and by using this model for the specified research problem. An evaluation method for virtual learning application was identified.

The updated DeLone and McLean (1992/2003) IS success model and Alter's work system model and theory were utilized to develop a virtual learning application and to deswcribe an

evaluation process for measuring performance or usability. DeLone and McLean IS success model classifies system quality, information quality and service quality, which are essential components for measuring virtual learning applications. However, by implementing a virtual learning system it was possible to take the virtual learning system's properties into account, when the specified evaluation criteria were investigated. By utilizing DeLone and McLean IS success model and Alter's work system, I could show that the virtual learning environment and virtual learning applications are possible to evaluate by using Information Systems evaluation methods. The evaluation processes were identified by the classifying process ex-ante, ongoing and ex-post evaluation, which underlines the importance of evaluation in the information systems lifecycle.

A minor scientific contribution was that I were able to create a structure of the evaluation research by using the Verschuren and Hartog's (2005) general design science model, and to show that the modified design science structure is usable. I propose that the modified structure of design science can be used for carrying out evaluation processes.

7.3 Implications for practical evaluation processes

In the practitioners'point of view, the evaluation method for virtual learning application applicable to offers a tool a specified information systems evaluation. The identified evaluation method for research process can be utilized the following:

1. The structure of evaluation research process is also applicable to use as guideline, when developing evaluation project in ex-ante situation.
2. Our study emphasizes needs of careful investigation of evaluation situation and the roles of decision-makers in evaluation process.
3. I point out that the roles of evaluator groups must be analyzed, since members of evaluator groups possess different status and roles in organization (formal and informal) and they have multiple and conflicting objectives concerning information system's use and implementation.
4. Our study revealed that it is possible to use Excel to calculate evalution results.

7.4 Limitation of the study

This research was carried out using only one case and six research units. It can be argued that the research results can not be generalized because the research is based on only a single case. However, I stress that, the main objective of the study was to develop ex-ante evaluation method for a virtual learning application based on the specified learning method and requirements of four stakeholder groups. I point out that by developing an evaluation method that only includes one case and that case includes six virtual learning applications, it is possible to test the developed model and analyze the calculated results, even for only one case. The demonstration material was created for demonstration purposes only, even if the calculated results revealed that

our ex-ante evaluation method produced results that can be recommended for decision-making. During this study process, it has been developed other and sophisticated virtual learning applications, which should be evaluated and considered, how these application can be used in learning and teaching.

7.5 Implication to the future research

With regards to the discussions of future research subjects, it can be argued that one way to continue is to start to develop software for evaluation method. For example, by using Java programming language it is possible to define and develop an application that is easy to use for this type of evaluation processes. The second way to continue is to start to develop a so-called generic evaluation method application. It is true that, among others, Mustajoki and Hämäläinen (1999, 2000) have developed multi-criteria decision-making applications that are possible to use, when evaluating virtual learning applications. I suggest that in the future our ex-ante models should be tested by using evaluation answers of members of the evaluator groups and develop a consensus ranking, which is an important question for group decision-making situation. I agree with Saaty (2006, p. 200) "In group decision making, aggregation of the preference ranking of individuals into a consensus ranking is the most important problem." It can be considered, if consensus is necessary in every evaluation situation. If it is impossible to achieve consensus, then it has to accept that recommendations include more than one proposal. Saaty (2006, p. 201) proposed that it could be possible to use deterministic or statistic approaches to solve this problem.

7.6 Conclusions

This research process took several years to carry out. It has to be admitted the process took longer than expected. It has been useful, since the researcher's 'scientific' thinking and ability to use research tools have become more sophisticated, and the thinking tools have developed during the research process. In order to get thinking tools and be able to proceed, it has been useful participating in research seminars and writing reviews. It has revealed that the research process and the production of good and relevant research reports need knowledge of research methodology and methods and a deep understanding of design science approaches in Information Systems research domain.

An evaluation method for a virtual learning application is created and demonstrated. I point out that developed evaluation method take four stakeholder groups into account, so it can be produced recommendations for the decision-making, which are consistent. The design research model that is developed for this study, my mind it is a o useful guide for the evaluation process. It takes the needed activities into account. It is also demonstrated that at the complicated calculation AHP-method is possible to carry out using by standard worksheet tools. Excel and other worksheet applications include matrix-calculation properties.

Appendixes

Appendix 1: Study results of virtual learning environments

During the first years of virtual universities, many questions arose: whether a virtual university is efficient and useful for students and teachers and is it benefical for the university itself. Anderson (1999) tried to answer these questions by carrying out a case research in Australia. Anderson (1999) states three questions while studying virtual universities. The focus of these questions is from an information technology perspective.

"1) how do students and academics benefit from the virtual university?
2) What kinds of problems are associated with virtual universities, and what are their future implications for students and the academics?
3) What guidelines universities should follow when transforming to a virtual university?"

Table A1.1 Advantages and Disadvantages of Virtual Universities.

Advantages	Disadvantages
Learning is time and geographically independent.	Faculty members must relearn their teaching and research processes.
Student actively participate their learning process, and have more control over their learning.	Faculty members must learn to use the web-technology.
Lower cost to students.	Academics need more time to develop subject material.
Access to current materials.	Limitations in time, and knowledge of the technology could affect the completeness and correctness of subject materials.
Increased retention of knowledge.	Learning barriers can be created trough hardware malfunctions, remote dial-in problems, and heavy web-traffic.
Learning becomes more individualized, and hence suitable for all students.	Limited university funds could restrict the virtual university's teaching and learning environment.
Increased interaction and collaboration between students and academics.	Curriculum and course schedule and timing are important and there is need to allocate resources more than traditional teaching methods.
Students develop more independent learning skills.	
Provides students with more accessibility to peers and academics.	

I believe that these questions are relevant even today. The results of that case research are collected in Table A1.1. Anderson uses other researchers' studies, when he tries to show, what

are the advantages and the disadvantages of virtual universities. These studies were performed between years 1996 – 1998. It can be argued that the main results are still valid after ten years, since the similar results are reported in other studies later.

In the United Kingdom, research of the virtual learning environment use has organized from 2001 to 2005. Jenkings et al. (2005) report the longitudinal research results that reveal the use of the virtual learning environment in the United Kingdom in universities and higher educational institutions. The interesting results show that strategic decision-making is still rare, even if the use of the virtual learning environment has increased from 2001 to 2005. The main conclusions that the researchers find are as follows (2005, pp.5-6):

"1. Uptake of VLEs has continued to increase, with higher education colleges now on a par with pre- and post-92 institutions.

2. The number of VLEs in use at a given institution is beginning to decrease, but with pre-92 universities still displaying the greatest diversity.

3. Blackboard and WebCT continue to dominate. Other proprietary software is declining but there is an increase in in-house and open source approaches.

4. Post-92 universities demonstrate the biggest increases in use by both students and staff.

5. Access to course material continues to account for the greatest VLE usage, but particularly in post-92 universities, there is increasing usage that is not merely supplementary (i.e. optional for students). Usage is conspicuous across a very wide range of subjects.

6. Central IT continues to dominate technical support. Elsewhere, dedicated VLE units appear to be absorbing the support previously provided more diversely.

7. The integration of VLEs with Managed Learning Environment (MLE) s has increased both in ranges of activities and in depth. In particular, there is a substantial increase in the creation of student account files for transfer to a VLE. However, there is limited progress in integration with portal development and *e*-portfolios.

8. Strategy and decision-making are becoming ever more consolidated centrally and are being substantially informed by external agencies. However, there is also an increase in local consultation. *E*-learning and VLEs are increasingly being cited in strategy documents.

9. Learning and teaching activities are consolidated as the primary drivers for considering the use of a VLE. Specialised support such as that required for distance learners and students with special needs are identified as significant factors but have had little impact on the character of resource provision.

10. Availability of funding is now the primary stimulant to VLE development, and a small percentage of this is still as project funding, though assured institutional funding now dominates.

11. Perceptions regarding the use of career enhancement as a means of encouraging VLE usage are very low, but there is an increase in expectation that staff will use VLEs.

12. Standards are neither seen as supportive nor as barriers, indeed, do they have negligible influence.

13. Most institutions are not yet using innovative technologies such as wireless and mobile phones, though post-92 universities are most active in this area.

14. The requirement to implement Personal Development Planning is beginning to have a small but noticeable impact on VLE usage. The development of *e*-portfolio capabilities is an emerging concern for higher educational institutes."

The results that are important from point of view of this research, concern the number of the virtual learning environments that are used in a single higher educational institution (HEI). The higher education institution that were founded before 1992:

37 % used one VLE,
24 % used two VLEs,
20 % used three VLEs,
7 % used four VLEs, and
10 % used five VLEs.

The most commonly used VLE were Blackboard 42 % and WebCT 40 %. The survey carried out in 2005 revealed that open source application Moodle achieved 13 % of use. The researchers speculate that some institutions are using more than one virtual learning environment, which could be due to different organizational culture. The second result that is worth to commenting on here is that the decision-making is highly centralized on in pre-92, since 84 % of the decisions are made at the institutional level and in post-92 HEIs the decisions are more centralized with 90 % of the decisions being made at the institutional level. The third result reveals that at the institutional level, virtual learning strategy is still 56 % of the institutes in 1995, and a development plan exists in 38% without specified strategy. Jenkings et al. argue that virtual learning is accepted on a general level, but integrated teaching and learning strategy and an e-learning strategy is still in a developing stage, since the e-learning strategy is in 53% of the institutions.

In United Kingdom (UK) operates the Joint Information System Committee (JISC) and its mission "is to provide world-class leadership in the innovative use of ICT to support education and research" (www.jisc.ac.uk). One strategic theme is 'e-Learning' in the strategy 2007-2009, and the aim "is to promote development, uptake and effective use of ICT to support learning and teaching." In their strategy, they have recognized new technologies and identify these: "Mobile technologies, social media, and tools that facilitate online reflection and collaboration are growing in popularity and relevance for teaching and learning. In particular recent Web 2.0 technologies such as Myspace, You Tube, wikis, blogs etc. have changed the learner experience. As ICT and e-learning becomes even more widely used in schools the skills of new students, and their expectations of the college and university learning experience, will increase. The *Department for Education and Skills* (DfES) e-strategy and related initiatives will enable this improvement in competencies to become even more widespread over the next five years. However, it cannot be assumed that all *Further Education* (FE) and *Higher Education* (HE) learners will be using, let alone proficient, in these new technologies; certainly not adult learners." (Italics added by researcher).

Sinko and Lehtinen (1999) carried out survey research of the ICT use in Finnish universities and polytechnics. The first goal of this survey was to find out how and to what extent ICT is used in learning and teaching in higher education. The other goals of the survey were to identify: "What added value does ICT bring to teaching and learning? What obstacles stand in the way of implementing ICT? How do different user groups view the future and the possibilities of developing ICT in teaching and learning? How does ICT support contacts between higher education and the business sector?" (1999, pp. 109-110). The survey results revealed that both

teachers and students posses the basic ICT skills (word processing, e-mail, operating system, web browsing). The researchers emphasized that it may among those teachers and students, who did not answered to the survey could have had lower basic skills. This assumption is supported by our own evaluation among 20 teachers, since the teachers' own evaluation of their own basic skills was higher than the test results. The test was carried out after teachers had completed their own evaluation and was organized so that the tester observed teachers, while they worked with word-processing tools, worksheet tools, presentation tools, and e-mail. The observed results were at a lower level compared to teachers own evaluations. The obstacles that hinder ICT use in teaching were identified as the following reasons:

1) the lack of time,
2) the teacher's own ICT skills,
3) the lack of pedagogical skills,
4) the lack of technical support,
5) the teachers' reserved attitudes, and
6) the limited number of student workstations.

In Finland, a survey carried out in polytechnics and universities showed similar results (Keltomäki et al. 2001). Suikkanen (2001) has performed review virtual learning environment use in the library system in Finnish universities. This review concentrates on the learning material that is available via the library systems. From this point of view the research is limited and does not give a real picture of the use of the virtual learning environment: after eight years the situation and use of ICT has changed rapidly and the exact survey results are not even available. For example, the Virtual University and the Virtual Polytechnic projects have started and produced some results concerning the use of ICT in teaching and learning in higher education in Finland. In Finland, the *Information and Communication* (TieVe) project for the Finnish Virtual University (FVU) offered training in the education use of information and communication technologies (ICT) in 2001-2006 (Peurasaari, 2008). The TieVe project arranged two types of training programmes: basic skills in the use of ICT in teaching and expert training programme for support and development staff. The information strategy for education and research 2000-2004 includes four challenges: 1) ensure necessary skills for information and communication use in education, 2) develop online learning environments, 3) secure the structures of the information society and 4) develop digital learning resources. By comparing aims of the JISC and objectives of the TieVe, it can be argued that ICT in teaching and learning is a new phenomenon, and virtual learning environments and virtual learning applications are still developing.

Appendix 2. Evaluated virtual learning environments and applications 1999.

In the United Kingdom use of virtual learning environments are evaluated by using an evaluation method, which is developed by Britain & Liber (1999). This evaluation process includes Blackboard, Learning space and WebCt, which are selected for evaluation in this study too. Britain and Liber carried out virtual learning environment evaluation and they selected the following applications:

Application	***Organization***	***URL***
ARIADNE EPF	Lausanne (EC DG XIII)	http://ariadne.unil.ch/tools/
Asymetrix Librarian	Asymetrix	http://www.asymetrix.com/
CourseInfo	Blackboard Inc	http://www.softarc.com/
CoMentor	Huddersfield University	http://comentor.hud.ac.uk
CoSE	Staffordshire University	http://www.staffs.ac.uk/cose
FirstClass Classrooms	SoftArc	http://www.softarc.com/
Learning Landscapes	TOOMOL Project, UW – Bangor	http://toomol.bangor.ac.uk
Learning space	Lotus Education of Lotus Institute	http://www.lotus.com/
TopClass	WBT Systems	http://www.wbtsystems.com/
Virtual - University	Virtual Learning Environments Inc.	http://www.vlei.com/
Web Course in a Box	MadDuck Technologies	http://www.madduck.com/
WebCT	WebCT, Univ. British Columbia	http://www.webct.com/

It is good to recognize that some of these applications are still available. Organizations are developers of the applications.

Appedix 3. The context evaluation method for virtual learning environment

The evaluation of virtual learning environment context is outside of this study, therefore the evaluation method that the Hyper Media Laboratory of Tampere University of Technology started a development project for evaluation tools together Virtual University of Finland from 2003 to 2004, the outcomes of which was a tool for evaluation and reflection is only briefly presented. The tool is called Arvo. According to the web site, which was organized by Silius (2004), the Arvo-tool includes nine different sub-areas for evaluation and reflection. This tool is suitable for the evaluation and reflection of virtual learning environment content. The developers describe the tool as "… offer a wide selection of questions with practical hints for developing those aspects. Usability, accessibility and informational quality can all be evaluated with the help of ARVO. ARVO can be utilized, either while evaluating already finished Web-based learning environments or during the process of designing them". The sub-areas are:

a) the presentation of information (47 questions),
b) the reliability of information (54 questions),
c) Visual planning tools (27 questions),
d) the readability of text content (18 questions),
e) the elements of media (52 questions),
f) the support of navigation (55 questions),
g) technical elements (41 questions),
h) the ease of use (43 questions), and
i) the support of different user groups of the portal (150 questions).

Each elements of the sub-area are evaluated by using the following scale: always, almost every time, some times, seldom, never, is not suitable and cannot say (no opinion) and this scale is converted to a value of one to five and after answering an evaluator can take out of the result and save them. Carrying out a total evaluation means that an evaluator has to answer to 487 questions. However, the user interface of the tool is planned so that the evaluator can answer by using one sub-area at time and continue an evaluation process later on, which is good thing.

Appendix 4. The calculated evaluation results

Evaluation method for virtual learning application **Main results**

Decision matrix	**Evaluator group/evaluator**					**Students**			
A virtual learning application	**NL**	**Ch**	**Di**	**Fh**	**Gw**	**Re**	**Cr**	**Rank value**	**Rank**
Blackboard (BB)	0,167	0,072	0,057	0,300	0,061	0,074	0,035	0,095	**4**
Future Learning Environment (FLE)	0,167	0,305	0,439	0,193	0,435	0,392	0,062	0,378	**1**
Discendum Optima (DO)	0,167	0,325	0,251	0,141	0,255	0,263	0,144	0,246	**2**
Learning Space (Lotus) (LS)	0,167	0,066	0,048	0,108	0,047	0,050	0,109	0,060	**6**
Moodle (M)	0,167	0,176	0,157	0,169	0,134	0,171	0,332	0,157	**3**
WebCT (WCT)	0,167	0,056	0,048	0,088	0,069	0,050	0,318	0,065	**5**
Total	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	

Criterion ranking = Cr

Decision matrix						**Teachers**			
A virtual learning application	**Nl**	**Ch**	**Di**	**Fh**	**Re**	**Qu**	**Cr**	**Rank value**	
Blackboard (BB)	0,081	0,084	0,058	0,084	0,079	0,239	0,035	0,138	**3**
Future Learning Environment (FLE)	0,244	0,251	0,398	0,275	0,248	0,197	0,054	0,246	**2**
Discendum Optima (DO)	0,244	0,251	0,280	0,392	0,441	0,349	0,083	0,368	**1**
Learning Space (Lotus) (LS)	0,081	0,084	0,045	0,049	0,046	0,040	0,160	0,047	**6**
Moodle (M)	0,188	0,191	0,100	0,085	0,080	0,116	0,293	0,106	**4**
WebCT (WCT)	0,160	0,140	0,119	0,116	0,107	0,058	0,376	0,095	**5**
Total	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	

Decision matrix						**ICT staff**			
A virtual learning application	**Ap**	**Mp**	**Acb**	**Am**	**Pp**	**Os**	**Cr**	**Rank value**	
Blackboard (BB)	0,231	0,267	0,067	0,258	0,056	0,288	0,079	0,202	**3**
Future Learning Environment (FLE)	0,194	0,153	0,345	0,162	0,417	0,163	0,323	0,230	**2**
Discendum Optima (DO)	0,317	0,387	0,157	0,328	0,292	0,095	0,167	0,278	**1**
Learning Space (Lotus) (LS)	0,045	0,035	0,067	0,056	0,043	0,085	0,136	0,052	**6**
Moodle (M)	0,133	0,094	0,302	0,133	0,123	0,160	0,147	0,151	**4**
WebCT (WCT)	0,081	0,065	0,061	0,062	0,069	0,210	0,147	0,087	**5**
Total	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	

Criterion ranking = Cr

Decision matrix	**Evaluator group/evaluator**					**Executives**			
A virtual learning application	**Vm**	**Sp**	**Lm**	**Acb**	**Pp**	**Os**	**Cr**	**Rank value**	
Blackboard (BB)	0,054	0,403	0,138	0,106	0,211	0,046	0,102	0,174	**3**
Future Learning Environment (FLE)	0,399	0,245	0,372	0,318	0,085	0,231	0,194	0,305	**1**
Discendum Optima (DO)	0,280	0,158	0,241	0,126	0,398	0,175	0,369	0,217	**2**

Learning Space (Lotus) (LS)	0,049	0,036	0,043	0,126	0,065	0,075	0,169	0,061	**6**
Moodle (M)	0,169	0,079	0,156	0,197	0,102	0,280	0,083	0,155	**4**
WebCT (WCT)	0,049	0,079	0,051	0,126	0,140	0,192	0,083	0,088	**5**
Total	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	

Criterion ranking = Cr

Evaluation method for virtual learning application

	Students											
Selection criteria	Nl	Ch	Di	Fh	Gw	Re	MxM					
Network login	1,0	0,2	0,2	0,3	0,2	0,3	6,0	4,4	2,8	2,9	1,5	1,0
Chat	5,0	1,0	0,2	0,3	0,2	0,3	14,0	6,0	3,7	4,5	2,5	2,6
Discussion	5,0	5,0	1,0	1,0	0,2	0,3	40,0	16,0	6,0	7,3	3,6	4,4
File handling	3,0	3,0	1,0	1,0	0,2	0,3	28,0	13,6	5,2	6,0	2,8	3,1
Group writing	5,0	5,0	5,0	5,0	1,0	0,3	76,0	52,0	18,0	19,3	6,0	7,3
Reflection	3,0	3,0	3,0	3,0	3,0	1,0	60,0	45,6	25,2	26,0	8,4	6,0
Total												

Selection criteria	**Network login**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	1,0	1,0	1,0	1,0	1,0	6,0	6,0	6,0	6,0	6,0	6,0
Future Learning Environment (FLE)	1,0	1,0	1,0	1,0	1,0	1,0	6,0	6,0	6,0	6,0	6,0	6,0
Discendum Optima (DO)	1,0	1,0	1,0	1,0	1,0	1,0	6,0	6,0	6,0	6,0	6,0	6,0
Learning Space (Lotus) (LS)	1,0	1,0	1,0	1,0	1,0	1,0	6,0	6,0	6,0	6,0	6,0	6,0
Moodle (M)	1,0	1,0	1,0	1,0	1,0	1,0	6,0	6,0	6,0	6,0	6,0	6,0
WebCT (WCT)	1,0	1,0	1,0	1,0	1,0	1,0	6,0	6,0	6,0	6,0	6,0	6,0
Total												

Selection criteria	**Chat**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,3	0,3	1,0	0,3	1,0	6,0	1,6	1,5	6,7	3,2	8,0
Future Learning Environment (FLE)	3,0	1,0	1,0	3,0	3,0	5,0	26,0	6,0	5,6	28,0	12,0	36,0
Discendum Optima (DO)	3,0	1,0	1,0	5,0	3,0	5,0	28,0	6,7	6,0	30,0	12,7	38,0
Learning Space (Lotus) (LS)	1,0	0,3	0,2	1,0	0,3	1,0	5,6	1,5	1,4	6,0	2,8	7,3
Moodle (M)	3,0	0,3	0,3	3,0	1,0	5,0	16,0	4,0	3,6	16,7	6,0	19,3
WebCT (WCT)	1,0	0,2	0,2	1,0	0,2	1,0	4,8	1,3	1,2	5,2	2,3	6,0
Total												

Selection criteria	**Discussion**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,2	0,3	1,0	0,3	1,0	6,0	1,0	1,8	7,3	3,1	7,3
Future Learning Environment (FLE)	5,0	1,0	3,0	5,0	5,0	5,0	44,0	6,0	11,3	60,0	22,7	60,0
Discendum Optima (DO)	3,0	0,3	1,0	5,0	3,0	5,0	26,7	3,9	6,0	34,7	10,7	34,7
Learning Space (Lotus) (LS)	1,0	0,2	0,2	1,0	0,2	1,0	5,2	0,9	1,6	6,0	2,5	6,0
Moodle (M)	3,0	0,2	0,3	5,0	1,0	5,0	18,0	3,1	4,3	20,7	6,0	20,7
WebCT (WCT)	1,0	0,2	0,2	1,0	0,2	1,0	5,2	0,9	1,6	6,0	2,5	6,0
Total												

Selection criteria	**Filehandling**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	3,0	3,0	1,0	3,0	1,0	8,0	13,3	12,7	24,0	12,7	30,0
Future Learning Environment (FLE)	1,0	1,0	1,0	3,0	1,0	3,0	8,7	10,0	8,0	14,0	8,0	16,0
Discendum Optima (DO)	0,3	1,0	1,0	1,0	1,0	3,0	6,0	6,0	5,3	11,3	5,3	13,3
Learning Space (Lotus) (LS)	1,0	1,0	0,3	1,0	0,3	1,0	4,2	6,0	5,3	7,3	5,3	8,0
Moodle (M)	0,3	1,0	1,0	3,0	1,0	3,0	8,0	8,0	6,0	13,3	6,0	15,3
WebCT (WCT)	1,0	0,3	0,3	1,0	0,3	1,0	3,6	5,3	4,7	5,3	4,7	6,0
Total												

Selection criteria	**Group writing**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,2	0,3	1,0	0,3	1,0	6,0	1,0	1,8	8,7	3,3	6,0
Future Learning Environment (FLE)	5,0	1,0	3,0	5,0	5,0	5,0	44,0	6,0	11,3	60,0	24,0	46,7
Discendum Optima (DO)	3,0	0,3	1,0	5,0	3,0	5,0	26,7	3,9	6,0	38,7	12,0	25,3
Learning Space (Lotus) (LS)	1,0	0,2	0,2	1,0	0,3	0,3	4,9	0,8	1,5	6,0	2,7	4,7
Moodle (M)	3,0	0,2	0,3	3,0	1,0	3,0	14,0	2,3	3,5	20,7	6,0	12,7
WebCT (WCT)	1,0	0,2	0,2	3,0	0,3	1,0	7,6	1,3	2,0	10,0	3,6	6,0
Total												

Selection criteria	**Reflection**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,5	0,3	1,0	0,3	1,0	7,5	1,6	2,7	8,8	3,6	8,8
Future Learning Environment (FLE)	5,0	1,0	3,0	5,0	3,0	5,0	38,0	7,5	10,7	50,0	18,7	50,0
Discendum Optima (DO)	3,0	0,3	1,0	5,0	3,0	5,0	26,7	5,2	6,0	34,7	10,0	34,7
Learning Space (Lotus) (LS)	1,0	0,2	0,2	1,0	0,2	1,0	5,2	1,2	1,6	6,0	2,1	6,0
Moodle (M)	3,0	0,3	0,3	5,0	1,0	5,0	18,7	4,3	4,7	21,3	6,0	21,3
WebCT (WCT)	1,0	0,2	0,2	1,0	0,2	1,0	5,2	1,2	1,6	6,0	2,1	6,0
Total												

Evaluation method for virtual learning application

Teachers

An evaluation criterion	Nl	Ch	Di	Fh	Re	Qu						
Network login (Nl)	1,0	0,2	0,2	0,2	0,3	0,3	6,0	4,9	4,8	3,8	1,8	0,9
Chat (Ch)	5,0	1,0	0,3	0,3	0,2	0,2	14,5	6,0	5,3	3,7	2,8	2,3
Discussion (Di)	5,0	3,0	1,0	0,2	0,2	0,2	27,2	9,6	6,0	4,4	3,3	2,8
File handling (Fh)	5,0	3,0	5,0	1,0	0,2	0,2	51,2	24,0	14,0	6,0	4,3	3,7
Reflection (Re)	3,0	5,0	5,0	5,0	1,0	0,3	82,0	42,3	38,9	14,9	6,0	4,7
Quizzes (Qu)	3,0	5,0	5,0	5,0	3,0	1,0	90,0	55,6	52,3	28,3	10,0	6,0
Total												

Selection criteria	**Network login**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,3	0,3	1,0	0,3	1,0	6,0	2,0	2,0	6,0	4,7	5,1
Future Learning Environment (FLE)	3,0	1,0	1,0	3,0	1,0	3,0	18,0	6,0	6,0	18,0	14,0	15,3
Discendum Optima (DO)	3,0	1,0	1,0	3,0	1,0	3,0	18,0	6,0	6,0	18,0	14,0	15,3
Learning Space (Lotus) (LS)	1,0	0,3	0,3	1,0	0,3	1,0	6,0	2,0	2,0	6,0	4,7	5,1
Moodle (M)	3,0	1,0	1,0	3,0	1,0	0,3	15,3	5,1	5,1	15,3	6,0	12,7
WebCT (WCT)	1,0	0,3	0,3	1,0	3,0	1,0	14,0	4,7	4,7	14,0	7,3	6,0
Total												

Selection criteria	**Chat**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,2	0,2	1,0	0,3	1,0	7,3	1,5	1,4	6,7	8,0	6,4
Future Learning Environment (FLE)	5,0	1,0	1,0	3,0	3,0	5,0	22,0	4,5	4,1	20,0	24,0	19,2
Discendum Optima (DO)	5,0	1,0	1,0	5,0	3,0	5,0	22,0	4,5	4,1	20,0	24,0	19,2
Learning Space (Lotus) (LS)	1,0	0,3	0,2	1,0	0,3	1,0	7,3	1,5	1,4	6,7	8,0	6,4
Moodle (M)	3,0	0,3	0,3	3,0	1,0	0,2	19,3	4,0	3,6	17,3	10,7	16,5
WebCT (WCT)	1,0	0,2	0,2	1,0	5,0	1,0	15,3	2,4	2,3	14,7	10,7	6,9
Total												

Selection criteria	**Discussion**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,2	0,2	1,0	0,3	1,0	6,0	1,0	1,5	8,0	5,2	4,4
Future Learning Environment (FLE)	5,0	1,0	3,0	5,0	3,0	5,0	44,0	6,0	10,0	54,0	33,3	32,7
Discendum Optima (DO)	5,0	0,3	1,0	5,0	3,0	5,0	30,7	4,7	6,0	40,7	25,3	19,3
Learning Space (Lotus) (LS)	1,0	0,2	0,2	1,0	0,3	0,3	5,3	0,8	1,4	6,0	3,2	3,8
Moodle (M)	3,0	0,3	0,3	3,0	1,0	0,3	12,7	2,0	2,9	13,3	6,0	8,0
WebCT (WCT)	1,0	0,2	0,2	3,0	3,0	1,0	16,0	2,3	2,8	18,0	8,5	6,0
Total												

Selection criteria	**Filehandling**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,3	0,3	1,0	1,0	1,0	6,0	2,4	1,5	11,3	7,3	6,0
Future Learning Environment (FLE)	3,0	1,0	0,3	5,0	3,0	5,0	20,0	6,0	4,7	38,7	26,7	17,3
Discendum Optima (DO)	3,0	3,0	1,0	5,0	3,0	5,0	28,0	10,0	6,0	52,0	34,7	30,7
Learning Space (Lotus) (LS)	1,0	0,2	0,2	1,0	0,3	0,3	3,9	1,5	1,0	6,0	3,9	3,8
Moodle (M)	1,0	0,3	0,3	3,0	1,0	0,3	7,3	2,7	1,8	11,3	6,0	6,0
WebCT (WCT)	1,0	0,2	0,2	3,0	3,0	1,0	9,2	2,9	2,4	18,0	9,2	6,0
Total												

Selection criteria	**Reflection**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,3	0,3	1,0	1,0	1,0	6,0	3,1	1,5	11,3	7,3	6,0
Future Learning Environment (FLE)	3,0	1,0	0,2	5,0	3,0	5,0	19,6	6,0	4,4	38,0	26,3	16,7
Discendum Optima (DO)	3,0	5,0	1,0	5,0	3,0	5,0	34,0	14,0	6,0	62,0	40,7	40,7
Learning Space (Lotus) (LS)	1,0	0,2	0,2	1,0	0,3	0,3	3,9	1,9	1,0	6,0	3,9	3,8
Moodle (M)	1,0	0,3	0,3	3,0	1,0	0,3	7,3	3,3	1,7	11,3	6,0	6,0
WebCT (WCT)	1,0	0,2	0,2	3,0	3,0	1,0	9,2	3,3	2,4	18,0	9,2	6,0

Total

Selection criteria	**Quizzes**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	3,0	1,0	3,0	1,0	3,0	6,0	10,5	4,4	38,0	18,0	30,0
Future Learning Environment (FLE)	0,3	1,0	0,3	5,0	3,0	5,0	7,3	6,0	3,6	36,7	11,3	23,3
Discendum Optima (DO)	1,0	3,0	1,0	5,0	5,0	5,0	11,3	12,7	6,0	58,0	23,3	44,7
Learning Space (Lotus) (LS)	0,3	0,2	0,2	1,0	0,3	0,3	1,4	2,2	0,9	6,0	2,7	4,7
Moodle (M)	1,0	0,3	0,2	3,0	1,0	3,0	4,3	5,5	2,7	20,7	6,0	12,7
WebCT (WCT)	0,3	0,2	0,2	3,0	0,3	1,0	2,3	2,7	1,5	10,0	3,6	6,0
Total												

Evaluation method for virtual learning application

ICT staff

IT staffs	Ap	Mp	Ac	Am	Pp	Os					
Administrative properties (Ap)	1,0	0,3	0,2	0,3	1,0	1,0	6,0	2,8	3,7	4,5	3,9	3,9
Maintenance properties (Mp)	3,0	1,0	3,0	5,0	1,0	1,0	38,0	6,0	13,6	16,0	14,0	14,0
Application cost-benefit properties (Ac)	5,0	0,3	1,0	1,0	1,0	1,0	16,0	4,5	6,0	7,3	9,3	9,3
Application maintenance properties (Am)	3,0	0,2	1,0	1,0	1,0	1,0	13,6	3,7	5,2	6,0	7,2	7,2
Platform properties (Pp)	1,0	1,0	1,0	1,0	1,0	1,0	14,0	3,9	7,2	9,3	6,0	6,0
Open Source (Os)	1,0	1,0	1,0	1,0	1,0	1,0	14,0	3,9	7,2	9,3	6,0	6,0
Total												

Selection criteria	**Administrative properties**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	3,0	0,3	5,0	3,0	1,0	6,0	9,9	6,5	32,0	17,3	29,3
Future Learning Environment (FLE)	0,3	1,0	0,3	3,0	3,0	5,0	8,3	6,0	5,8	32,7	10,0	22,0
Discendum Optima (DO)	3,0	3,0	1,0	3,0	1,0	5,0	12,9	17,3	6,0	48,0	22,7	32,0
Learning Space (Lotus) (LS)	0,2	0,3	0,3	1,0	0,3	0,3	2,0	2,4	1,2	6,0	2,7	5,2
Moodle (M)	0,3	0,3	1,0	3,0	1,0	3,0	7,4	6,3	3,8	20,7	6,0	14,0
WebCT (WCT)	1,0	0,2	0,2	3,0	0,3	1,0	3,4	5,1	2,1	13,2	5,5	6,0
Total												

Selection criteria	**Managerial properties**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	3,0	0,3	5,0	5,0	3,0	6,0	11,3	4,9	50,7	22,7	32,7
Future Learning Environment (FLE)	0,3	1,0	0,2	5,0	3,0	3,0	3,9	6,0	3,5	30,7	10,9	18,3
Discendum Optima (DO)	3,0	5,0	1,0	5,0	3,0	3,0	10,3	22,0	6,0	68,0	38,7	40,7
Learning Space (Lotus) (LS)	0,2	0,2	0,2	1,0	0,3	0,3	1,2	2,2	0,7	6,0	3,0	3,5
Moodle (M)	0,2	0,3	0,3	3,0	1,0	3,0	3,1	4,5	2,4	19,3	6,0	9,6
WebCT (WCT)	0,3	0,3	0,3	3,0	0,3	1,0	2,4	4,0	1,6	12,0	5,3	6,0
Total												

Selection criteria	**Application cost-benefit properties**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,2	0,3	1,0	0,3	1,0	6,0	1,2	2,9	6,0	1,5	6,7
Future Learning Environment (FLE)	5,0	1,0	3,0	5,0	1,0	5,0	32,0	6,0	14,0	32,0	7,3	34,0
Discendum Optima (DO)	3,0	0,3	1,0	3,0	0,3	3,0	14,7	2,8	6,0	14,7	3,6	15,3
Learning Space (Lotus) (LS)	1,0	0,2	0,3	1,0	0,3	1,0	6,0	1,2	2,9	6,0	1,5	6,7
Moodle (M)	3,0	1,0	3,0	3,0	1,0	5,0	28,0	5,2	12,7	28,0	6,0	30,0

WebCT (WCT)	1,0	0,2	0,3	1,0	0,2	1,0	5,6	1,1	2,5	5,6	1,4	6,0
Total												

Selection criteria	**Application mainentance properties**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	3,0	0,3	3,0	3,0	3,0	6,0	11,3	6,3	28,7	12,0	28,0
Future Learning Environment (FLE)	0,3	1,0	1,0	3,0	1,0	3,0	6,0	6,0	4,0	18,0	8,0	16,0
Discendum Optima (DO)	3,0	1,0	1,0	5,0	3,0	3,0	10,0	16,7	6,0	34,0	18,7	32,0
Learning Space (Lotus) (LS)	0,3	0,3	0,2	1,0	0,3	1,0	1,8	2,5	1,3	6,0	2,9	5,6
Moodle (M)	0,3	1,0	0,3	3,0	1,0	3,0	4,0	5,3	3,4	14,7	6,0	14,0
WebCT (WCT)	0,3	0,3	0,3	1,0	0,3	1,0	2,2	2,7	1,4	6,7	3,3	6,0
Total												

Selection criteria	**Platform properties**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,3	0,2	1,0	0,3	1,0	6,0	1,4	2,5	8,7	3,3	5,3
Future Learning Environment (FLE)	3,0	1,0	5,0	5,0	3,0	3,0	48,0	6,0	12,8	56,0	34,7	44,7
Discendum Optima (DO)	5,0	0,2	1,0	5,0	5,0	5,0	35,6	6,4	6,0	46,0	15,6	32,3
Learning Space (Lotus) (LS)	1,0	0,2	0,2	1,0	0,3	0,3	4,9	1,0	1,7	6,0	2,7	4,3
Moodle (M)	3,0	0,3	0,2	3,0	1,0	3,0	14,0	3,3	3,9	20,7	6,0	12,0
WebCT (WCT)	1,0	0,3	0,2	3,0	0,3	1,0	8,0	1,8	2,9	10,7	4,0	6,0
Total												

Selection criteria	**Open Source**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	5,0	1,0	1,0	5,0	1,0	10,0	17,2	53,3	36,0	20,4	10,0
Future Learning Environment (FLE)	1,0	1,0	5,0	1,0	1,0	1,0	9,2	10,0	17,3	24,0	13,2	9,2
Discendum Optima (DO)	1,0	0,2	1,0	3,0	0,2	1,0	6,2	9,6	6,0	9,2	11,2	6,2
Learning Space (Lotus) (LS)	1,0	1,0	0,3	1,0	0,2	1,0	4,4	8,3	8,7	6,0	11,5	4,4
Moodle (M)	0,2	1,0	5,0	5,0	1,0	0,2	11,6	9,2	17,1	26,4	6,0	11,6
WebCT (WCT)	1,0	1,0	1,0	1,0	5,0	1,0	6,0	13,2	33,3	32,0	16,4	6,0
Total												

Evaluation method for virtual learning application

Executives

An evalution criterion	ViMi	Sr	Lm	Acb	Pp	Os						
Vision/Mission	1,0	0,2	0,3	0,3	3,0	3,0	6,0	9,1	2,8	8,9	10,5	10,5
Supplier reputation	5,0	1,0	0,2	3,0	1,0	1,0	20,3	14,0	3,3	10,7	21,6	21,6
Learning method	3,0	5,0	1,0	5,0	3,0	3,0	48,0	31,6	6,0	32,0	28,0	28,0
Application cost-benefit properties	3,0	3,0	0,2	1,0	1,0	1,0	22,3	9,6	2,7	14,0	15,6	15,6
Platform properties	0,3	1,0	0,3	1,0	1,0	1,0	10,0	7,7	1,5	7,8	6,0	6,0
Open Source	0,3	1,0	0,3	1,0	1,0	1,0	10,0	7,7	1,5	7,8	6,0	6,0
Total												

Selection criteria	**Vision/Mission**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,2	0,2	1,0	0,3	1,0	6,0	1,0	1,5	6,7	2,3	6,7
Future Learning Environment (FLE)	5,0	1,0	3,0	5,0	3,0	5,0	44,0	6,0	10,0	50,0	18,7	50,0
Discendum Optima (DO)	5,0	0,3	1,0	5,0	3,0	5,0	30,7	4,7	6,0	36,7	10,7	36,7
Learning Space (Lotus) (LS)	1,0	0,2	0,2	1,0	0,2	1,0	5,6	0,9	1,5	6,0	2,1	6,0
Moodle (M)	3,0	0,3	0,3	5,0	1,0	5,0	19,3	3,4	4,3	21,3	6,0	21,3
WebCT (WCT)	1,0	0,2	0,2	1,0	0,2	1,0	5,6	0,9	1,5	6,0	2,1	6,0
Total												

Selection criteria	**Supplier reputation**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	3,0	5,0	5,0	3,0	3,0	6,0	10,7	22,0	68,0	34,7	34,7
Future Learning Environment (FLE)	0,3	1,0	3,0	5,0	3,0	3,0	4,3	6,0	10,7	44,7	20,7	20,7
Discendum Optima (DO)	0,2	0,3	1,0	5,0	3,0	3,0	3,5	4,3	6,0	30,7	12,3	12,3
Learning Space (Lotus) (LS)	0,2	0,2	0,2	1,0	0,3	0,3	0,7	1,3	2,2	6,0	2,8	2,8
Moodle (M)	0,3	0,3	0,3	3,0	1,0	1,0	1,8	2,7	4,3	14,0	6,0	6,0
WebCT (WCT)	0,3	0,3	0,3	3,0	1,0	1,0	1,8	2,7	4,3	14,0	6,0	6,0
Total												

Selection criteria	**Learning methodology**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,2	0,3	3,0	3,0	1,0	14,0	2,3	3,1	18,7	8,8	22,7
Future Learning Environment (FLE)	5,0	1,0	3,0	5,0	3,0	5,0	34,7	6,0	10,7	54,0	32,7	50,0
Discendum Optima (DO)	3,0	0,3	1,0	5,0	3,0	5,0	23,3	4,3	6,0	34,7	18,7	34,7
Learning Space (Lotus) (LS)	0,3	0,2	0,2	1,0	0,3	1,0	4,3	0,8	1,4	6,0	3,1	6,0
Moodle (M)	3,0	0,3	0,3	3,0	1,0	5,0	14,7	3,0	4,3	23,3	14,0	19,3
WebCT (WCT)	1,0	0,2	0,2	1,0	0,2	1,0	4,5	0,9	1,6	7,6	4,9	6,0
Total												

Selection criteria	**Application cost-benefit**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,3	1,0	1,0	0,3	1,0	6,0	2,0	5,3	5,3	4,0	5,3
Future Learning Environment (FLE)	3,0	1,0	3,0	3,0	1,0	3,0	18,0	6,0	16,0	16,0	12,0	16,0
Discendum Optima (DO)	1,0	0,3	1,0	1,0	1,0	1,0	8,0	2,7	6,0	6,0	4,7	6,0
Learning Space (Lotus) (LS)	1,0	0,3	1,0	1,0	1,0	1,0	8,0	2,7	6,0	6,0	4,7	6,0
Moodle (M)	3,0	1,0	1,0	1,0	1,0	1,0	12,0	4,0	10,0	10,0	6,0	10,0
WebCT (WCT)	1,0	0,3	1,0	1,0	1,0	1,0	8,0	2,7	6,0	6,0	4,7	6,0
Total												

Selection criteria	**Platform properties**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	3,0	1,0	1,0	3,0	1,0	6,0	14,7	4,5	28,0	17,3	9,3
Future Learning Environment (FLE)	0,3	1,0	0,2	3,0	1,0	0,3	4,5	5,1	1,9	11,3	6,0	3,3
Discendum Optima (DO)	1,0	5,0	1,0	5,0	5,0	5,0	15,3	21,3	7,5	56,0	34,7	16,0
Learning Space (Lotus) (LS)	1,0	0,3	0,2	1,0	0,3	0,3	2,8	5,1	1,7	6,0	6,0	2,9
Moodle (M)	0,3	1,0	0,5	3,0	1,0	0,3	4,8	6,6	2,2	12,8	7,5	4,8

WebCT (WCT)	1,0	0,3	0,2	3,0	3,0	1,0	6,3	8,7	3,6	18,0	11,3	5,1
Total												

Selection criteria	**Open Source**											
Alternatives	BB	FLE	DO	LS	M	WCT	MxM					
Blackboard (BB)	1,0	0,2	1,0	1,0	0,2	1,0	6,0	8,4	6,0	6,0	6,3	5,0
Future Learning Environment (FLE)	5,0	1,0	5,0	5,0	1,0	5,0	30,0	42,0	30,0	30,0	31,5	25,2
Discendum Optima (DO)	1,0	5,0	1,0	1,0	0,2	1,0	30,0	13,2	30,0	30,0	11,1	29,0
Learning Space (Lotus) (LS)	1,0	1,0	1,0	1,0	0,5	1,0	11,5	10,7	11,5	11,5	7,4	9,1
Moodle (M)	5,0	5,0	5,0	5,0	1,0	0,2	45,2	41,2	45,2	45,2	11,5	40,4
WebCT (WCT)	1,0	1,0	1,0	1,0	5,0	1,0	34,0	33,2	34,0	34,0	11,9	10,0
Total												

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