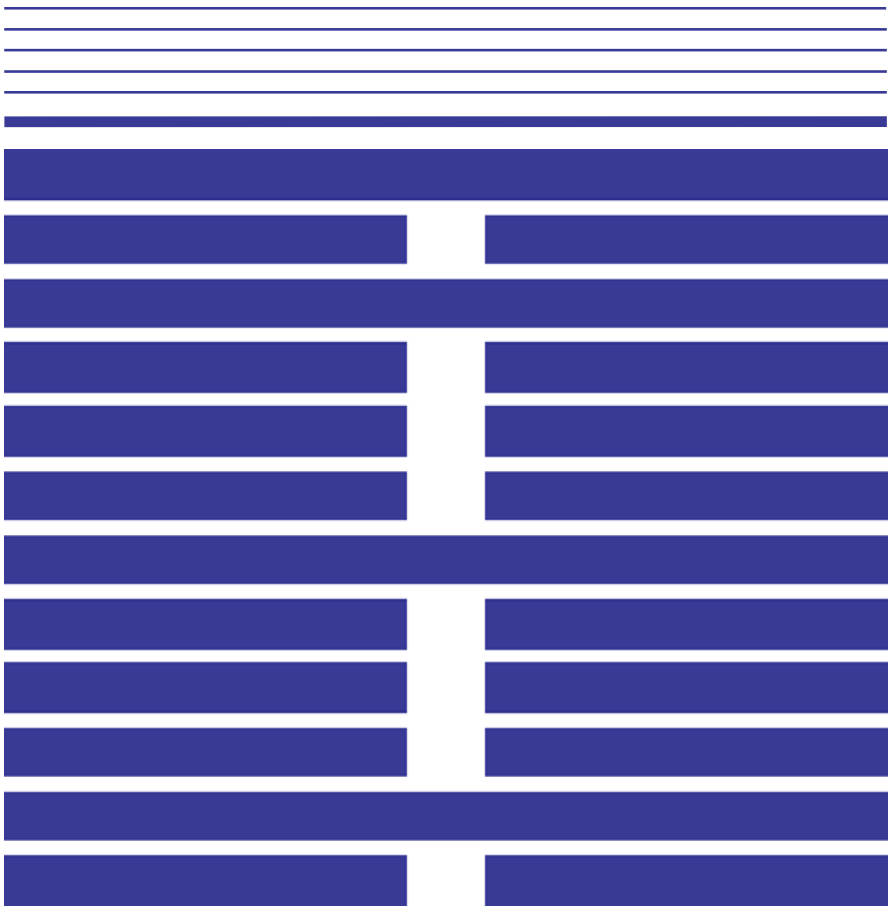
JYVÄSKYLÄ STUDIES IN COMPUTING
79

Ari Wahlstedt

Stakeholders' Conceptions of Learning in Learning Management Systems Development



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UNIVERSITY OF JYVÄSKYLÄ

JYVÄSKYLÄ 2007

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JYVÄSKYLÄ 2007

Editors
Seppo Puuronen
Department of Computer ScienceandInformation Systems,University of Jyväskylä
Irene Ylönen, Marja-Leena Tynkkynen
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Cover picture by Ari Wahlstedt. The two hexagrams on the cover were found to be the most suitable illustrative descriptions of learning from the literature (cf. Huang 1998, 66–73, 293–298). The Chinese characters (cf. Senge et al. 1994) on the page seven describe also learning as proceedings forward from the immaturity, alike a young bird rising from the water.

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ABSTRACT

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We receive and send information via communication channels such as writing. However, our thoughts and conceptions are noticed only at a certain detailed level when expressed in simpler forms, for example, with words. The conceptions of learning (CoL), a person's associations, memory content, ideas and beliefs related to learning, are used to understand learning management systems development (LMSD). The learning management systems, considered as information systems, help teachers to manage their courses and provide possibilities for collaboration in learning. From a humanistic perspective, LMSD involves continual social and physical construction of an artifact. LMSD is a change process taken on object systems in a set of environments by a development group to achieve or to uphold some objectives. In that participation, the interactions of LMSD stakeholders include CoL. This research goes beyond the requirement analysis stage in system development, concentrating on the conceptions which guide people in their actions. As CoL should be noticed, the research aim was to find out what are those CoL in the LMSD. For the background, related issues in computer, educational and cognitive science were studied. With a case study, interviews and a web-survey with stakeholders, this research gathered their CoL. Research results were revised categories of CoL, issues related to these conceptions, a method for gathering conceptions and an agent-technology based approach to LMSD to support dynamical CoL.

Keywords: E-learning, learning management systems, learning management systems development, information systems development, stakeholder, conception of learning

ACM COMPUTING REVIEW CATEGORIES

H.1.2 IS: Models and Principles: User/Machine Systems
Human information processing
Human factors
K.3.1 Computing Milieux: Computers and Education: Computer Uses in Education
Computer-assisted instruction (CAI)/Computer-managed instruction (CMI)

Author's address

Ari Wahlstedt
University of Jyväskylä
Dept. of Computer Science and Information Systems
P.O. BOX 35, 40014 Jyväskylä, Finland
E-mail: ari.wahlstedt@jyu.fi

Supervisors

Professor, Dr.Tech., Pasi Tyrväinen
Dept. of Computer Science and Information Systems
University of Jyväskylä, Finland
E-mail: pasi.tyrvainen@jyu.fi

Professor, Ph.D., Päivi Häkkinen
Institute for Educational Research
University of Jyväskylä, Finland
E-mail: paivi.hakkinen@ktl.jyu.fi

Reviewers

Professor, Ph.D., Michael J. Hannafin
Dept. of Educational Psychology and Instructional Technology
University of Georgia, USA

Professor, Dr.Tech., Jari Multisilta
Advanced Multimedia Center
Tampere University of Technology, Finland

Opponent

Professor, Ph.D., Erkki Sutinen
Dept. of Computer Science
University of Joensuu, Finland

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"*Clouds follow the dragon, winds follow the tiger*"
- I Ching (from Marshall, S. J. 2001, 136)

Answers to difficult questions are simple, but difficult to put in words, because words or books can't fully express our thoughts, although some music might come close. Thus, internal stimulus can't be understood in the original manner by using external stimulus. As the quality and amount of interaction effect what is perceived, there is some purpose to use words. Yet understanding depends on momentary interpretations.

In this research, focus on learning has been central for me to understanding what is happening in these interactions among humans and between humans and their environment. In physics, interaction[1] means the transfer of energy among elementary particles or fields, or between elementary particle and field (e.g. Ohanian 1989, 1130). Similarly, here interaction refers to the information transfer among people. In that transfer, emotions[2] are present. Those emotions can be broken down into three general classes (Ortyny et al. 1988, 18): Reactions to events, agents, and objects. Frijda (1986) proposes that emotions follow stages of appraisal, context evaluation, action readiness, and physiological change, expression or action. Though the discussion about emotions dates beyond Aristotle (Oatley & Jenkins 1996, 11), and emotions are present in learning, they are not studied here. However in profound studies about learning, emotions should be also studied, as being central and pervasive aspects of human experience (Norman 1981). Related to emotions, the theory of dynamic systems (Fogel et al. 1992), views that several genetically derived components become organized into patterns of interaction. In this developmental view the components become linked, responsive to features of the environment, but also constraining each other as the system develops. In interactions of such systems with the social[3] world, further interdependencies occur. The whole system of person-with-other becomes self-organizing, and emotions occur as modes of interaction among components and external events. As Hutchins (1996, 169) points out that humans create their cognitive powers by creating the environments in which they exercise those powers.

As the interaction starts at some moment of time, ironically at the same time it starts to end. So there is a reason to thank every moment of interaction and I want to acknowledge my gratitude to all the people with whom I have been privileged to hold discussions during these long and exciting years. Some of the people are next mentioned. And those people who I missed – thank you.

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1 A combination of words 'inter', which refers to meanings "among" or "between", and 'action', which refers to for example "set in motion" or "move" (Harper 2001).

2 All those feelings (evaluations) that so change (people) as to affect their judgments, and are also attended by pain or pleasure (Aristotle 1378a, 1.20 e.g. in Barnes 1984).

3 The tendency to associate with others and to form social groups relating to human society and its members. Friendly companionship with others (Harper 2001).

My supervisors, Professors Päivi Häkkinen and Pasi Tyrväinen never stopped. It was amazing that regardless of how odd or convoluted the situation, they had always time and were able to understand the novice researcher. They clarified what could be done, but still I got the possibility to decide what to do next. The learning via our discussions is incomparable. In the beginning, in spring 2003, emeritus Professor Pertti Järvinen gave excellent IS seminars and valuable notions about research work. As well as Professors Pertti Saariluoma, Minna Koskinen, Hanna-Kaisa Isomäki, Erno Lehtinen, and Sanna Järvelä shared kindly some of their knowledge in the various phases of this research. Professors Michael Hannafin and Jari Multisilta gave valuable comments in the finalizing of this dissertation, and Professor Seppo Puuronen skillfully advised in the publishing process of this dissertation. I cordially thank you all them for their professional perspectives and wisdom they shared. And, as expressing thoughts by writing requires practice, Professor Samuli Pekkola, Dres. Marketta Niemelä and Anne Honkaranta, Ms. Sirpa Vauhkala, and Ph.D. students, Shenghua Liu, Matti Järvenpää (ad perpetuam memoriam) and Piritta Leinonen showed that there is no limit in writing, and that every perspective has its pros and cons. With a positive attitude they co-authored and gave support in writing and dealing with interesting research issues. Dear co-authors, thank you - it has been a privilege to do research with you.

The University of Jyväskylä, the Graduate School in Computing and Mathematical Sciences and the INFWEST program provided essential resources for this research. For this support I wish to first acknowledge the Rector of the University of Jyväskylä, Professor Aino Sallinen, and Professors Pekka Neittaanmäki and Juhani Iivari, as well as all the people working in the university making this research possible. Many thanks to Mesdames Sanna Hirvola, Essi Laine, Seija Paananen, Lea Hakala, Seija Haapaviita, Messrs Tapio Tammi, Jari Rahikainen, Jouko Kääriäinen and others who have helped in the many practical issues. Special thanks to Ms. Anya Siddiqi and Mr. Hannu Hiillos (ad perpetuam memoriam) who gave valuable advice on how to improve upon my English. And, as the research is done mostly in the 'dark research chambers' - Dr. Jarmo Sarkkinen, Lic. Janne Kaipala, and Mesdames Henni Palomäki and Katariina Valtonen, I thank you for the valued discussions as otherwise this research would had been 'a lonely caveman's journey'. Also the researchers, who contributed to this research through sometimes very short but sometimes quite joyful scientific or non-scientific discussions – Professors M. Newman, J. Puustjärvi, Kinshuk, E. Cohen, H. Dreher, B. Lewis, A. Barnard, D. Bialaszewski, D.-J. Chen, Dres. Z. Kovacic, A. Cartelli, R. Hijon-Neira, E. Hill Sr., R. Hämäläinen, J. Pöysä, M. Arvaja, A. Heimbürger, A. Kumar, K. Mäkitalo-Siegl, M. Fong, M. Ueno, H. Parkkola, M. Kankaanranta, R. Bekele, H. O'Lawrence, A. Pirhonen, K. Eto, D. Randall, D. Mwanza-Simwami, N. Buzzetto-More, M. Santorineos, S. Zoi, M. Pechenizkiy, Ph.D. students M. Vilenius, L. Kolås, M. A. Chatti, K. Liimatainen, A.-M. Tervakari, P. Bonanno, A. Yalaho, E. Jauhiainen, S. Nešić, T. Pavlou, E. Vasilyeva, I. Skrypnyk, Mesdames, E. Sillman, J. Whatley, B. Floyd, G. Tan, K. Silius, Messrs K. Whittington, R. Williams, P. Makkonen, and M. Pallot, thank you.

From my perspective, despite the shared wisdom in the academic community, there are also other communities where outstanding persons make positive effect on human lives and make our world a better place to live. Thus, I want to acknowledge my sensei, renshi Henri Kosonen for setting my target levels as high as possible, polishing my spirit, and for guiding me to surpass my expectations and barriers physically and mentally. I respectfully thank for him his skills of teaching Taido (cf. Shukumine 1993) in which he is the best. I also respect my fellow taidokas who have shared the sweat and spirit in the dojo - Domo arigatoo gozaimasu. At the same time, yogini Linda Taakala and yogi Frank Kappas guided me in finding the gift of caring and the science of Yoga (cf. Jois 2002). They helped me to find the peace in my body, when the times were difficult. Truly, the purpose of life can be towards friendliness and truthfulness in our every breath, increasing the fulfillment in life. – Shanti.

The meaning of silence is to have a perspective and a beginning. As for me, silence is the way to concentrate on learning about phenomena in the world. I want to remember my deceased father for giving me that direction. I miss the discussions we had when I was too young to understand how important it is to have a father. With my dear son, there is again the intelligent joy of being together. As for my loving mother, there are no words to describe the love that I have got and how much it has continued to help me in my life - knowledge is nothing without care. And my dear brothers, sisters, and friends, who are in every aspect of multidimensional life the best, thank you for sharing with me those valued moments.

In the beginning and hopefully in the end of life, love is the strongest human emotion. The love of a parent for her child, the love of a martyr for his cause, the love of two adolescents for each other - these are the elements that inspire great poetry, music, and art. When experiencing the heights of love, individuals are most prone to extreme changes of mind and heart. There is no greater motivator and hopefully the most admired acts in human life are inspired by love. In my journey, among many people, only one has stepped deeply into her place in my heart without doubt, without any mismatch. She is the lifelong reason to learn and to seek for perfection in all rhythms of the heart.

In Jyväskylä,
Ari Wahlstedt

LIST OF FIGURES

LIST OF TABLES

CONTENTS

LIST OF INCLUDED ARTICLES

1. Wahlstedt, A. 2006. Over 283 693 reasons to elaborate education, work and apply E-learning. In E. Cohen (Ed.) Proceedings of the Informing Science and Information Technology Education (InSITE) Joint Conference. Santa Rosa, CA, USA: Informing Science Institute, 299-305.

2. Wahlstedt, A. 2006. Roles in learning management systems development. In M. Khosrow-Pour (Ed.) Proceedings of the International Resources Management Association (IRMA) Conference "Emerging trends and challenges in information technology management". Hershey, PA, USA: Idea Group Publishing, 522-524.

3. Wahlstedt, A., Niemelä, M. & Pekkola, S. From e-learning space to e-learning place. British Journal of Educational Technology. To be published.

4. Wahlstedt, A. 2005. The time and the design of web-based learning environment. In E. B. Cohen (Ed.) Issues in Informing Science and Information Technology, Vol. 2. Santa Rosa, CA, USA: Informing Science Press, 335-345.

5. Wahlstedt A. 2007. A method based on the semantic differential for studying e-learning stakeholders' conceptions of learning. In M. B. Nunes & M. McPherson (Eds.) Proceedings of the International Association for Development of the Information Society (IADIS) E-learning conference, Vol. 2. IADIS Press, 213-217.

6. Wahlstedt. A., Liu, S. & Honkaranta, A. Advantages and challenges for supporting users with agent-based learning management systems. Special issue of the International Journal for Virtual Reality. Submitted.

LIST OF ACRONYMS

CoL	Conceptions of Learning
DG	Development Group (Welke 1983; Lyytinen 1987a)
IS	Information System
ISD	Information Systems Development
LMS	Learning Management System
CMS	Content Management Systems / Course Management System
LCMS	Learning Content Management System
LMSD	Learning Management Systems Development
OS	Object Systems (Welke 1983; Lyytinen 1987a)
VLE	Virtual Learning Environment

1 INTRODUCTION

"*Man the living creature, the creating individual, is always more important than any established style or system.*"
- Lee Jun-Fan (1940-1973)

We are creatures of the Earth, and we change and need to adapt to the changes in our environment. We are able to change our actions, because we perceive and use information from our environment. As Norman (2004, 20) expresses it, human beings have evolved over millions of years to function effectively in the rich and complex environment of the world. Our perceptual systems, limbs, motor system and many other features have evolved to make us function better in the surrounding world. Still, as animals, we use movements, gestures and sounds to interact. A body language (Ekman 1993; Argyle & Dean 1965) is used when in direct (e.g. face-to-face) contact with someone, and no extra tool is necessary when communicating[4] over a short distance. Over longer distances we use words and extra tools like books, websites and newspapers, offering a medium and a channel for sending or receiving information and details of conceptions and thoughts. Despite many methods of communication, we might not always completely understand the other and their message, thus causing misunderstandings in communication. One reason is the semantics of communication signals, which depend on understanding the signal in a certain context. At the same time, that richness of meanings is the source of creativity; for example, one "sees" different things than the other.

Indeed, we communicate from a perspective, from a particular point of reference, or worldview (Russo & Stolterman 2000, 313). How we see or sense things are - what has happened, what is happening and what is going to happen. We are physically and mentally somewhere in some position, with a perspective. Naturally this is not static, but what forms processes like learning,

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4 Communication (c. 1384, L. *communicationem* orig. *communicare* "to impart, share", lit. "to make common", Harper 2001) refers here to the known Lasswell maxim, "Who says what to whom in what channel with what effect". In general, the interaction as information mediated between A) senders e.g. writers and B) receivers, e.g. readers.

is the change in the state of things (a set equilibrium, Bernard 1957, orig. 1865) around us (environment) and inside us (cognition[5]). If we consider the human body, at times we need to change to a different state according to our needs. This phenomenon in the human body is called rheostasis (Mrosovsky 1990). When a change occurs in our body, there are two ways that our body can respond. The first one is negative-feedback: the body responds in such a way as to reverse the direction of the change. This is the response that is involved in preserving constant conditions inside the body (homeostasis[6], Cannon 2007, orig. 1932). The second one is positive-feedback: if a change occurs in some variable, the response is to change that variable even more in the same direction so that it results in a continuing spiral of change (rheostasis). Eventually, negative feedback may take over to put a limit on things. Claude Bernard (1813-1878) noticed the constancy of the internal milieu as conditions to a free life. That is, we strive to preserve a set equilibrium.

When we communicate with others, with the help of the right words we identify objects around us, build knowledge and perceive, for example, mathematical functions, theories, and concepts and systems of concepts. We can recall from memory a certain presentation, when someone uses the right words. For example, in information systems development (ISD), in the requirement analysis phase, the right words are needed to describe the users' needs and the available technological possibilities back to users. Ironically, we try harder to explain the world and us, but at the same time produce more names and words to be understood and to be remembered. It is easy to misunderstand that we understand things only by naming them or by using words. In addition to naming, we classify, itemize and divide all things around us, and we get pieces, parts and bits of the whole. However, one could claim that we cannot shrink reality and make it into "byte-sizes". As said, used language cannot present what people think or what their whole perspective is on a certain issue. Despite this lack of total transfer of sense, people have achieved and created great inventions and masterpieces together. Perhaps because of we try to perceive and understand the things around us.

Although science is useful for understanding things, it can only generalize things in certain details. The deeper the levels of science systemizing things, the more names are needed to describe the difference between pieces. As Rohrer (2001) found, Posner and Raichle's (1994) schematization of levels of cognitive science useful for operationalizing the Lakoff-Johnson hypotheses about embodiment and conceptual metaphor, we also use that schematization of levels to define the limits of this research. From cognitive and conceptual systems to subcellular systems, those concepts which are more related to human conceptual systems, conceptions[7] of learning (CoL), were the target of

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5 Cognition is the flexible coupling of perception and action (Billman 1998, 649). It is used here to describe the interpretation of information from the outside world that is received through the senses. Cognition enables the perception of objects and events and an interpretation of them to occur. (Faulkner 1998, 12).

6 Original meaning "to remain the same" (Harper 2001).

7 More detailed in 1.3.1

this research. The term system[8] means here an assembly of interrelated and joined elements comprising a unified whole, typically having a common purpose in the environment. The context where CoL were studied was the development of learning management systems (LMSD) for e-learning. If we make a difference between e-learning, distance education and traditional learning, e-learning ('e 'is an abbreviation of the word 'electrical'[9]) can be described as learning with the help of some electrical devices and tools used in interaction, while distance education can be done without electrical devices e.g. via correspondence. Reading a printed book on the sofa is not e-learning, but reading an e-book with a mobile terminal (e.g. mobile phone) is considered to be e-learning. Further terms like hybrid learning, web-based learning, and virtual learning are our ways of describing familiar phenomenon with different words from different perspectives.

For clarification, LMS is seen in this research as a combination of technical IS and an educational system to be used for learning purposes. Technically, LMS usually runs on servers, to serve the course to students as internet pages. Passerini (2006) classifies LMS features to include course design (instructor-centered sample course, course templates, search tools, student home pages), course management (student grading and tracking, assessment tools, timed quizzes), collaboration (discussion, chat sessions, logs, bulletin board, e-mail, file sharing, whiteboard, workgroups) and administration (security, technical support). New features in these systems include, for example, blogs and Rich Site Summary feeds (RSS feeds). LMS are specifically designed to manage a wide range of learners, keeping track and store of their progress and performance across all types of training and performances. Large LMS typically include properties targeted at helping collaborative learning and integration with performance management systems. LMS performs heavy-duty administrative tasks, such as reporting to instructors, human resource (HR) and other enterprise resource planning (ERP) systems. LMS is also a high-level, strategic solution for planning, delivering, and managing most learning events within an organization, including online, virtual classroom, and instructor-led courses. To take an example, the US Army has an LMS, which is a web-based information system (Khan 2001), that provides training information management, collaboration, and scheduling and career planning in both resident and nonresident training environments. LMS as a solution is replacing isolated and fragmented learning programs with a systematic means of assessing and raising competency and performance levels throughout a learning organization (e.g. Paulsen 2003; Khan 2001). For example, an LMS can simplify global certification efforts, enable entities to align learning initiatives with strategic goals, and provide a viable means of enterprise-level skills management. There are hundreds of academic and commercial systems from

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8 The term "system" meanings: to combine, to set up, to place together (Harper 2001). A system receives inputs from and gives outputs into its environment.

9 The word *electronic* originates from the term *electron*, which is derived from the term *electric*, whose ultimate origin is the Greek word, meaning *amber* (Harper 2001).

which to choose: Open-source and free learning management systems competing directly with the large commercial offerings and others focusing on unique features (e.g. EduTools 2007).

As the learning management industry is new, overlapping and similar terms occur (cf. Paulsen 2003; Tsai & Machado 2003); content management system (CMS), course management system (also CMS), learning content management system (LCMS), virtual learning environment (VLE), web-based learning environment (WBLE), managed learning environment (MLE), learning support system (LSS) or learning platform (LP). Most of these terms (Course management system, VLE, WBLE, MLE, LSS, LP) refer to the technical solution as LMS. For example, in the United States, CMS (course) and LMS are the more common terms, although LMS is more often associated with corporate training management programs rather than courses in traditional education institutions. In the UK and many European countries, terms with the idea of "environment" are favored, for example, VLE and MLE. Next, some distinction is made of some of these terms, and probably in the future only few terms will be in use in order to establish clearer e-learning terminology.

For example, the difference between CMS (content) and LMS is that CMSs lack the user delivery and tracking mechanisms found in most LMSs. CMSs take care of all the "behind the scenes" work and separate the content from the presentation. CMS helps instructors catalog, track, and manipulate corporate information. A CMS is effective when large amounts of information must be tracked and managed and is ideal for large organizations. And as LCMS is LMS and CMS combined, it can be seen as a further development of the LMS. However, the term LMS is often used to refer to both an LMS and an LCMS. The important difference is that an LCMS provides tools for instructional designers and subject matter experts to create, store, author, manage, reuse and deliver learning objects (digital learning content, Hodgins et al. 2002), with the help of learning object repository. The advantage is that LCMS makes it possible to quickly answer the needs of individual learners' need of content. Rather than developing entire courses and adapting them to multiple audiences, instructional designers create reusable content chunks or learning objects and make them available to course developers and content experts throughout the organization. This removes double development efforts and allows for the rapid assembly of customized content. LCMS consists of a content authoring application, learning object repository, dynamic delivery interface, and learner administration tools. Although many LCMSs offer basic course administration features, their functionality is not as robust as that found in most LMSs.

LMSD is ISD, in which designers and content producers of educational software engage. Presented assumptions strive for the search for CoL from the stakeholders of LMSD. Despite the belief that e-learning is solemnized to be the next state of learning, and accepted as the needed phase in human development, one may need to be aware of political purposes (Contu et al. 2003) and underlying conceptions related to the usage of LMS. To better understand CoL and the stakeholders of LMSD, information from different

sciences were gathered. Research in computer science about IS and ISD (e.g. Hirschheim et al. 1995; Boland & Hirschheim 1987), in educational science about teaching, and learning environments and in cognitive psychology about memory, learning, brains, knowledge representation, thinking and perception were studied. That gathered knowledge was seen as basis for this research. This research was carried out also from a humanistic perspective (see e.g. Isomäki & Häkkinen 2001), as LMSD involves continuous social and physical construction of a design artifact (Häkkinen 1996). Between stakeholders of artifacts design and producing, there are interactions including different conceptions. The research hypothesis was that these subjective CoL influence the LMSD. Comparisons between CoL was used to explicate what is used in LMSD, preeminently highlighting the designers' and content producers' CoL.

As the systems are viewed as artifacts in ISD and the conceptions as the basic systems elements, first the related research issues in information science, educational science and cognitive psychology are reviewed. Then the research framework, research target and applied research methods are presented and framed, following a short summary of each research paper included. After the results and discussion, the conclusion ends this dissertation.

1.1 Information systems development

"Organizations are stable networks of transactions regulated over a period of relative stability by a set of contracts to govern transactions between their members."
- Claudio Ciborra 1987

According to Claude Shannon (1916-2001) and Gregory Bateson (1904-1980), information is 1) that which reduces uncertainty (Shannon 1948) and 2) a difference which makes a difference (Bateson 2000, 457-459). As there are other definitions of information (Capurro & Hjortland 2003; Tuomi 1999; Mingers 1995; Boland 1987), information systems (IS, e.g. Checkland & Holwell 1998; Boland 1987; Land 1985) and information systems development (ISD, e.g. Avison & Fitzgerald 1995; Lyytinen 1987a), we start with one of them.

Lyytinen (1987a, 6) has explained the essential components of ISD. Thus, ISD can be seen as a change process taken on object systems (OS, before and after a change) in a set of environments (where a change takes place) by a development group (DG) to achieve or uphold some objectives (Welke 1983). The DG ensures that ISD takes place (Robey & Markus 1984). It sets common expectations as it sanctions, punishes and gives rewards. It consists of roles and positions filled by people. Objectives, which express intentions in ISD, have several features that must be kept in mind when studying the IS change. They can be as follows: a) implicitly imposed, for example, by the methods used, or explicitly agreed upon through an open negotiation, or superimposed by fiat, b) clear or vague (ill-defined), c) uni- or multifunctional and d) conflictual or

conformity. According to Klein (1984) these objectives relate general value-orientations and represent what one ought to do or what is good. OS consist of phenomena perceived by DG members. They identify a target of change. In general, there are several OS, which a DG can identify. Furthermore, OS are often related, so a change in one can induce a change in others. Members' perceptions of OS need not coincide. Therefore, identified OS can be partially overlapping, disjointed and even conflicting. OS can be further characterized by their context, underlying concept structure, representation form, ontology, and epistemology. Environment should be viewed as "webs of conditions and factors" which surround development processes (see Kling & Scacchi 1982). They exert influence on development activities, organization, outcomes, and so on. Environments include labor, economy, technology, application and external and normative environments. Change process is an event in which phenomena, that is objects, properties and their relationships in OS, come into being because of a DG's deliberate action. It can be further characterized by its intentionality, intersubjectivity and uncertainty. ISD is intentional to the extent it reflects a planned change. It is based on developers' intentions to change OS towards desirable ends. The change process is founded on an intersubjective recognition of phenomena and on a common coordination of participant's actions. ISD is not an artificial adventure; it is always embedded in a social and cultural milieu. Uncertainty entails that the change process is not a deterministic one. Developers are often uncertain whether the planned intervention can be carried out, and whether the resulting OS will have the desired properties. In general, Lyytinen (1987b) distinguishes three types of uncertainty: means uncertainty, effect uncertainty and problem uncertainty.

The ISD components form a complicated web of social, technological and cultural phenomena. The components are not independent of each other, nor are they dependent. Rather, we can speak of a totality in which components' features are defined by their interactions with other components - they are, thus emergent. A detailed specification of one component is a case of a constrained choice: one component constrains our freedom to choose the others. For instance, identified OS are constrained largely by pursued objectives. Lyytinen (1987a) sees that people have viewpoints, which enable them to perceive OS, calling them OS contexts (Welke & Konsynski 1982). The notion of the OS context indicates the open-ended, situation-dependent and cyclical nature of IS intervention. OS can be represented in multiple ways. The chosen representation form depends primarily on the concept structure and its degree of accuracy and formality.

1.2 Information systems development challenges

"It is our contention that the major reason most information systems have failed is that we have ignored organizational behavior problems in the design and operation of computer-based information systems."
- Henry C. Lucas Jr. (1975, 6)

Software development is a challenging focus for process modeling because of the creative problem solving involved in requirement analysis and design, and the team interactions coordination during a complex intellectual artifact development (Curtis et al. 1992, 75). Because the lack of relevant knowledge transferred from the system users to developers, the ISD research should examine (Joshi & Sarker 2003) the factors that impede the transfer of knowledge among these people (e.g. Jenkins & Johnson 1977).

The reasons for IS failures are several (e.g. Lyytinen & Hirschheim 1988; Bostrom & Heinen 1977; Lucas 1975) and it is difficult to pinpoint singular reasons. For example, reasons can be in ISD, in IS use or in both (Lyytinen 1987b). In ISD 1) goals can be too ambiguous, narrow or conflicting, 2) technology is restricting choices and contains a high risk of change, 3) economical foundations are missing and quality of calculations is poor, 4) development process lacks quality control and good communication among stakeholders, and analysts dominate, 5) organizational and behavioral issues are neglected, and 6) self-image is rationalistic. IS use 1) may be too difficult, because IS interface is awkward and IS is slow and unreliable, 2) data are incorrect, lacking relevance or is incomprehensible or is missing, 3) the wrong problem is solved, 4) IS use has negative impact on work, power shifts and job qualification changes, and 5) IS is too complex to understand, maintain, and use. For example in the ISD requirements analysis phase, systems designers are developing the system with requirements from earlier projects, environments and users (analysts dominate). The reasons could be in the ISD management as well, such as the raising project expenses caused by the cost of repair of errors and sometimes the rebuilding of the system. Within these cases, the systems design has already used resources and the produced system is found to be a failure or an experiment. According to Bostrom and Heinen (1977) the major reason for IS failures and problems is the way system designers view organizations, their members, and the function of an IS within them.

In addition, the designing of an IS is a moral problem because it puts one party, the system designer, in the position of imposing an order over another (Boland 1987). Failures are going to happen, because designers cannot design wide systems, which would support individual action in a way that the system would operate from an individual human perspective. Often a specification of requirements is a document that is given to a customer to be accepted. Knowledge from the customers is acquired by asking about their wishes concerning the system. The challenges in this approach are, for example, the statistical nature of the documents, a too general use of language (leading to

misunderstandings) and not enough details about the system in the document. This may lead to a situation where the actual developers get an "old" document where the requirements are described using general language. Other issues, such as finding current persons in charge, managing priority issues of the requirements (e.g. which is the most important) and understanding the state of the requirements (still valid, approved or scheduled) needs a searching and analysis of available information from a static document. One solution for this approach has been softwares that give developers access to automatically see users' profiles and ISD managers' requirements definitions. At the same time they can view the related business operations to gain an overview of what these requirements are for. This view can be shared with other ISD stakeholders, for example, with system testers. Also, when there is transparency, in the requirements inchoation, it decreases the workload of management and makes it easier to find the reasons for changes in requirements. Still there is a question that can systems be designed for a large group of people to use. Yes, if the basic human actions principles (like learning or using specific tools) from earlier systems can be used, especially in a new system. On the other hand, people are individuals with common and different aims and ways of action – It is a substantial challenge to design 100% suitable systems for a group of people.

IS are for supporting decisions and actions, but sometimes it is good to look around and notice what IS are used in the decision and action situations. Despite the IS challenges and failures, designers design systems for users, organizations and sometimes for themselves. According to Faulkner (1998), once organizations are using a particular piece of system, it is difficult for them to extricate themselves, especially if they are a large organization and the system is used throughout that organization (as being 'locked into' a particular system). The cost of retraining an entire staff, both in term of financial outlay and time, might well be prohibitive. Even where the cost in financial terms is not considerable, the task of retraining is not to be taken lightly: people do not like to scrap the skills they already have. Because the user perceives information from the system via its interface, the interface must reduce the trauma of learning and maximize the ease of transition from the existing system to the new system. (Faulkner 1998, 8).

The user affects the state of the system by manipulating the system controls (e.g. keyboard). Thus, the user and the system interact inside a user's physical environment and this physical environment has effects on the efficiency of the interaction and to the system operations. The impact of the user's internal actions to the system is minimal, compared to the systems effect on the user's internal actions in interaction. However, system developers' impact to the system is greater than the systems effect on the system developers' internal actions. Thus, when interacting with the environment, people form internal mental models of themselves, and the artifacts of technology with which they interact (Johnson & Henderson 2002; Ehrlich et al. 1996). That internal action depends heavily on the conceptualizations brought to a task (Norman 1982).

1.3 Learning management systems development

"I'm not a master. I'm a student-master, meaning that I have the knowledge of a master and the expertise of a master, but I'm still learning. So I'm a student-master. I don't believe in the word 'master.' I consider the master as such when they close the casket."
- Lee Jun-Fan (1940-1973)

Technology has become an important instrument in education, but the main concepts of the different disciplines are still seen as important to teach to the beginner (Bransford et al. 1999). When we use electrical devices like computers in education, those devices are ports or windows which we use to access, see and produce the information that we need and to interact with others. These human-made artifacts help us, for example, to communicate, learn, design, observe and create, thus to change the earlier mentioned equilibrium state.

Concerning educational technology, the interaction can be defined as an exchange of information, ideas and opinions between and among learners and teachers, usually occurring through technology with the aim of facilitating learning. In the 21st Century people are excited by the prospect of information networks, such as the Internet, for linking students around the globe into communities of learners (Bransford et al. 1999). However, each learner has a dynamic way of learning and can use different systems around to gain information. The information that a motivated learner can achieve from a distance, with the help of new technology, is beyond the curriculum.

The information in e-learning is offered through IS. Those many IS are named in many ways, here they are referred to only as LMS, as IS have the purpose of facilitating and supporting learning. Also the principles of ISD are considered to cover some issues in LMSD.

1.3.1 Background of LMS

In the 19th Century, there were no computers or LMS (Bransford et al. 1999). And long before that, information was passed onto others via familiar communication, like gestures, speech, and paintings and further with the help of writings. The living environment of the human being, consisting of different perceivable issues such as flowers, animals, people and rocks, was the real learning environment. People who had more knowledge and wisdom than others were heard, respected or even feared if they possessed a type of knowledge that was needed, for example, to know when to sow a field. These people were called by different names, for example, shamans or masters.

Alhought, the term 'distance education' originates beyond the time the first computers were made and used (e.g. Edelson & Pittman 2001). Ancient people could hardly talk about distance education in the way it is currently understood. Although aboriginals, for example, had for a long time an interesting "LMS" (Kearins 1981), which have remarkable similarities to

internet-based learning and how scientific research work is done. Aboriginals used the nature around them to pass the information onto their followers such as their children. There were traditional trails, which could be followed to learn something about their culture and of course about nature. These learning paths were once traveled by their ancestors and were their teachers of everyday things essential for surviving. Each traveler left their "footprints" on these trails, increasing the information passed onto the next traveler. Just as current 'explorers', like children, use the Internet to gather information and leave traces of their actions. Or the manner in which researchers search for information from the vast space of information.

What was common to earlier interaction situations was that people were in a place, for example, hunters communicated while they were on hunting trips. People had ceremonies where certain information was passed onto younger generations e.g. Hopi-Indians Kivas (e.g. Loftin 1994). Thus, learning was mostly social interaction happening in a certain space and situation. Although people had their own perception of things, what was taught by the masters, what was heard and especially seen, was believed mostly to be true. Knowing something essential to survival was considered to be of great value, and people wanted to survive. There was a need to learn certain skills and gain knowledge, as it obviously still is. To gain this valuable knowledge, people went to a certain place to learn, and in that place, masters chose to teach those who wanted and who had the abilities to learn.

When societies developed, the value of saving and sharing knowledge was realized. The gathered knowledge needed to be transferred to other people in the society to sustain and to develop those societies. Society needed educated people to enhance their living conditions such as better workers. For example, in the Industrial age, the increase of specialized people for specialized work (e.g. for conveyor belt) was emphasized. Finally, learners (students) were educated in defined educational spaces (classrooms), where there were teachers who knew the issues that needed to be learned. (e.g. Bransford et al. 1999) Students traveled and gathered to hear those teachings considered to be important and valuable. Passing the core subjects (reading, writing, and calculating) was essential for students to socially improve themselves and to gain more knowledge. And according to (Edelson & Pittman 2001) already in 1885, William Harper (1856-1906) said:

> "The day is coming when the work done by correspondence will be greater in amount than that done in the classrooms of our academies and colleges"

By the end of 19th century, when communication and increased speed of transferring information across the world became possible, people did not need to travel far to learn from others. They could communicate with their teachers by correspondence and later via telephones. And more was coming. After WWII, Vannevar Bush (1890-1974) already predicted the future device for human assistance (1945, 6):

> "Consider a future device for individual use, which is a sort of mechanized private file and library...in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory."

After the electronic devices increased and people started to learn to use them, the amount of information "exploded". Lyman and Varian (2003) estimated that in 2002 there were roughly 800 MB of recorded information produced per person each year. For relevance, it would take about nine meters of books to store the equivalent of 800 MB of information on paper. In addition, the information flow (radio and television broadcasting, telephone calls and internet) via communication devices was increasing (in 2002: 17.7 exabytes).

With the help of digital technology, people are now creating virtual words and communities where people can virtually participate and learn. These virtual realities are artificial spaces, which look increasingly real. With the new technologies, information can be added into the physical environments (e.g. Tennenhouse 2000), thus combining virtual objects into physical environment, by immersive reality and ubiquitous computing (Gemmell et al. 2003). For example, an interactive pedagogical agent supporting or acting as a supplement to human instruction (Doswell 2004) brings a new participator to e-learning.

In general, artificial intelligence as in the form of an interactive pedagogical agent and LMS can be a great assistance in education by providing the framework for motivated, problem-based learning (Norman 2004). LMS can provide simulated worlds in which students can explore problems in different disciplines and science. In a virtual reality, intelligent pedagogical agents can evaluate the learner's understanding throughout the interaction, not moving on to more sophisticated concepts until it is clear the learner has a good understanding of the basics. Then the student is encouraged to step forward. Thus, intelligent pedagogical agents motivate students by prompting them to interact by asking questions, offering encouragement and giving feedback. While intelligent pedagogical agents cannot equal a skilled human teacher's attention and power, they can allow that same teacher to reach more students. They can offer a form of personalized instruction and add meaning to the vast amount of formless information available to learners on the web. For example, in a virtual learning environment, the virtual room is just as empty and abstract as a real room, but with intelligent pedagogical agents as active participators, and with other virtual objects, students can form spatial structures. However, as Harper (1885), according to Edelson and Pittman (2001, 10), well noticed about study guides, the aim is not to replace teachers or the natural environment with an artificial:

> "...not a substitute for the professor, but only for his or her physical presence. A good study guide extends an instructor's style, point of view, and to some extent, personality to students never met in person. At the same time, it should also reflect the instructor's standards, degree of rigor, and determination to make the course worthwhile."

1.3.2 Stakeholders' roles

"…I can show some really fancy movement. But to experience oneself honestly, not lying to oneself, and to express myself honestly, now that, my friend, is very hard to do"
– Lee Jun-Fan in the Pierre Berton Show (1971)

LMSD is considered in this research as consisting of design, content development, delivery and maintenance, LMS use and management, and marketing phases. Designing has been understood as a process of converting information originally presented in the form of requirements into the form of specifications (Hubka & Eder 1987). The design process is understood here as a sub-process of the development process; for example, as in the theory of software process improvement and capability determination, SPICE (El Emam et al. 1998). Before we concentrate on the four roles selected as essential for LMSD, we first briefly discuss the roles that people have and describe the roles that stakeholders involved in LMSD may have.

Thus, people have roles[10], although they are not all paid actors. Curtis et al. (1992) summarize role as a coherent set of process[11] elements to be assigned to an agent as a unit of functional responsibility. An agent is defined as an actor (human or machine) who performs a process element. Artifact is a product created or modified by this process element enactment.

During a single day a person might occupy several roles, such as that of a parent, driver, manager or customer. In the theory of roles (Moreno 1961), one's persona is seen as a band of roles, thus as a system of role groups. Individual's' role contains thoughts, emotions and ways of actions. As noted, roles are also situated into context, time, other people and objects. When a role emerges, it can be seen as creative action, but it can also prevent people's creativity if they are systematically stuck in only one role. Fortunately human roles develop through life and people omit roles and accept new ones. In addition, more roles enhance adaptability and purposefulness in different situations.

For clarification and identification, roles can be classified (cf. Moreno 1961) into psychosomatic (physical needs e.g. sleeper), psychical (cognitive needs e.g. survivor), social (context needs e.g. student) and spiritual (ethical and mental needs e.g. artist). Especially social roles are namely agreements between people, sometimes presented with detailed descriptions in documents. Roles also have similarities with other classifications like archetypes. In stories, arts, literature, religions, mythologies, and in dreams, archetypes are used to express the human being and human development (Pearson 1991). Pearson uses twelve archetypes to present the development of identity in three steps (preparation, journey and return). Each step symbolizes the identity's maturation from an ego through to a soul and contains an individual development story. For example, in the first step, in the preparation, archetypes related to one's family

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10 From L. *rotula*, meaning in ancient creek roll, where actor's speech was written (Harper 2001).

11 A set of partially ordered steps intended to reach a goal (Humbrey & Feiler 1992).

are studied. When a person understands the connections to one's inner child and inner parent (realization of ego), a person is ready for the next step, for the journey. Within the journey, a person finds a deeper connection to self - and "lets go of the old and creates something new" (realization of the soul). After the journey, a person returns home and finds their identity and harmony in life (realization of self). Clearly, archetypes present abstract delineation of human development, but can be used for studying different roles.

There are many possibilities to developing online courses, but when there is a need to develop new LMSs including courses, an organization typically first establishes a project team. Depending on the project size, this phase, before actual course content production, gathers organizations decision-makers together; directors of responsible organization, project managers, business managers, consultant, programmers, system administrators, interface designers and many other possible experts. Members of this project group may be the members of the developing organization, hired for the project or external members providing their resources when needed. Also, in a small or a medium sized project, members will be able to perform multiple roles and sometimes organizations might have only one stakeholder involved in LMSD.

Khan (2004) describes e-learning's P3 model, which helps to identify the roles and responsibilities for the design, development, evaluation, implementation, and management of e-learning and blended learning materials and systems. The P3 model contains two major phases with sub-phases, when a team is producing e-learning materials: (1) content development (planning, design, production, and evaluation) and (2) content delivery and maintenance (delivery, maintenance, instruction and marketing). In comparison, Sage (1995) defines three primary systems engineering life cycle phases (system definition, system development, system deployment) and the primary information flow as: definition → development → deployment.

In Table 1, roles related to the LMSD phases are positioned with adding the phase of establishing the project group as an initial definition phase of LMS. It is not necessary to consider these phases as following each other in strict order; instead one could consider them as supplementing each other when necessary. For example, content development could be outsourced to another organization, or marketing can happen during the continuous LMS development. Moreover if we consider the general baselines12 identified in systems development, such as user requirements baseline, system specifications baseline, functional baseline, allocated baseline or product baseline (Sage 1995, 7), people can have several roles within LMSD. Thus, some roles are relevant to specific phases, for example, the instructional designer is involved during the content development, whereas services from technical persons (e.g. system administrator) are mostly needed during the content delivery, maintenance and instruction phases. Note that all the roles described are not strictly necessary in small LMSD projects.

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12 Reference points in the system's lifecycle, where important configuration features are defined in detail (Sage 1995, 7).

TABLE 1 Emerging roles in different phases of LMSD

LMSD	**LMS Content development**				**LMS/Content delivery & maintenance**		**LMS/Content management**	
Start phase	*Planning*	*Design*	*Production*	*Evaluation*	*Delivery*	*Maintenance*	*Instruction*	*Marketing*
System admin			System admin		System admin	System admin	System admin	
Instructional designer	Instructional designer	Instructional designer		Instructional designer				
R&D coordinator	R&D coordinator	R&D coordinator						Market researcher
Project manager	Project manager	Production coordinator	Production coordinator					
Consultant	Consultant						Counselor	Consultant
Director	Director		Editor			Webmaster	Librarian	Recruiter
Business developer	Business developer						Customer servant	Salesperson
Interface designer		Interface designer	Graphic artist	Interface designer				
		Evaluation specialist	Course integrator	Evaluation specialist			Course coordinator	
		Content expert	Learning objects specialist				Course facilitator	
Database programmer			Photo/Video grapher			Database programmer		
Server programmer			Multimedia developer			Server programmer		
						Discussion moderator	Discussion moderator	
		Copyright coordinator	Quality assurance			Security officer	Registration person	
					Teacher	Teacher	Teacher	
			Student	Student	Student		Tutor	

In this research, roles like designer, content producer, teacher and user are used to present the basic social and task related roles as stakeholders involved in LMSD. As roles emerge in social situations, roles can be used to define groups of individuals as in requirement analysis. However, when speaking of roles as system for interaction, roles as internal structure are not emphasized. Furthermore, when describing a certain role's conceptions, we are not speaking of a certain individual's personal conception. Instead, we are speaking of a certain group of people, who have similarities in their personal accounts. As roles are developed or not used, the time and the context where they are presented need to be acknowledged also. Due to the evolving nature of conceptions as well as human roles, this research is mainly an old story about designers and content producers, and their CoL in the LMSD. We consider also two other actors: teacher and user. In this research the designer role is a role familiar in the LSMD and the content development phase, whereas the content producer role is more familiar in the content development, and delivery and maintenance phase. The teacher role is more present in the delivery and maintenance phase and in the instruction phase. The student role is more or less involved in the content production (more in Articles 2 and 3), evaluation and delivery phases.

Thus, when we need some new product, the designer's job is to identify, what the new product could be, and to create something that will satisfy the

requirements (Eteläpelto 1998). Schön (1987) sees designing as making, which involves complexity and synthesis. This means that unlike analysts or critics, designers put things together and bring new things into being; in so doing they deal with many variables and constraints, some initially known and some discovered through the design process (Eteläpelto 1998). All human constructive and creative activity can be perceived as design, for example, artists are clearly designers since they create artifacts like songs and paintings. Design can be seen as a cognitive process characteristic for all humans as noted in general and cognitive psychology (Goel & Pirolli 1992; Miller et al. 1960). The products of this cognitive process are external representations and present how things could be put together presenting, for instance, possible futures. Nevertheless designers are not always able to explain why they do what they do (Russo & Stolterman 2000, 321). The designer has to decide what knowledge to include into the design object and how to represent it to the user (Hannafin 1993; Häkkinen 1996). This knowledge is based on the information designers have gathered and thus depends on the designers' information management skills. The connection (quality) between information management and design of an artifact is clear, if we consider the designer as an architect who creates plans to be used in making something, for example, buildings, or LMS. Thus, designer designs based on the existing knowledge and discourse with other specialists (e.g. with a pedagogical specialist). In general, design and development are activities, which involve the goal-setting and constructive aspects of the distinctively human mind (Eteläpelto 1998). In designing and developing a new product, designers set themselves original goals and novel ideas as guides for the future; in so doing they engage in an intentional activity which can affect our environmental and social conditions. This implies that designers have to integrate a normative component into their activity when they define the goals and objectives entailed by their task (Eteläpelto 1998).

Producers can be defined as people who manufacture something, thus content for others to use. In e-learning, content producers are the people and organizations that produce learning materials (Horton & Horton 2003). These products are defined more precisely as learning objects, self-contained, reusable modules with metadata (Hodgins et al. 2002) for education or training. The content production is emphasized here, because it should foster content creation and development, supporting structural and incremental development and reusability of the resulting materials (suitable learning objects), and furthermore, the development of the information society (e.g. Catenazzi & Sommaruga 2002). The learning content can be exercises, simulations, questionnaires, diagrams, figures, graphs, indexes, slides, tables, narrative texts, exams, experiments, problems statements, self-assessments or lectures. This learning content can be a combination of static documents or other learning materials (Tyrväinen et al. 2003), such as webpages, educational applications, audio, images, messages, models, multipart, text and video, as well as, the links between content. This content may also be user created and changed documents. Learning content in LMs has additionally text, hypertext, hypermedia, links and discussion boards to increase interaction among content.

Thus, it is important to acknowledge the source for this content, the maker of this content, because the content producer is also involved in the interactions in LMSD. Although, content producers have a wide range production area (Table 1), they need a good component classification. Component classification comes from the designer, who has a more abstract view of needed components and LMS. As the designer gives a sketch of what could be and how, the content producer carries out the implementation with the help of the designer, for example, according to a design plan. From one point of view, the learning content can also work as a boundary object (Star & Griesemer 1989), like boundary actors (Koskinen & Pirinen 2007), offering constant focus, surrounded by discussion.

The teacher is a specialist of the context where the LMS is going to be used (e.g. school), and acts as a mediator between use and the design in LMSD. The traditional view of learning, which involves interaction with teacher, supervisor or with someone who has the required knowledge still has a place in e-learning. Someone is needed to direct the required knowledge to the user. Thus, the student is the planned user of the environment and the teaching via network becomes more supervised, the teacher's role changes more to that of supervisor, trainer, tutor, mentor, facilitator or coach (Vainionpää 2006).

This presented description of roles in the development is a general approach. However, obviously one actor, for example, the teacher can have the same characteristic as the designer, because sometimes the teacher can act as a designer (Kilpinen 2004). In certain situations the designer and content producer could be the same person, but in most LMSD, there is more than one person working together. Thus, one individual may hold many roles and a role may be assigned to several individuals (Curtis et al. 1992). All actors have their own CoL. Next, the interactions in LMSD are described.

1.3.3 Interactions

There can be many persons involved with different and similar conceptions in the LMSD (Häkkinen 1996, 2002; Isomäki & Häkkinen 2001). People involved in the development process, an organized or nonorganized DG, interact with each other and represent originating from their conceptions. In the Häkkinen's (1996, 43) original perspective, there were three separated roles interacting in the development and use of LMS (designer, teacher and student). In this research perspective, as the LMS combine various media and those media are the content of these environments, a content producer was included as an addition.

In relation to the presented perspective, there are also three assumptions concerning the roles in LMSD. First there is the weak interaction. According to earlier research (Häkkinen 1996), the interaction between designer and teacher is not as direct as it could be. The second assumption contributes to the first assumption, assuming there are mixed and overlapping roles. For example, the teacher or user (explorative learning) can be the designer or the content producer (e.g. Collins 2001; Kilpinen 2004; Hakkarainen et al. 1999). The third

assumption is that in LMSD there might be more roles that are not yet strongly present, but that will occur during the process (Khan 2001). Furthermore, LMS can be seen as being an instrument enriching the interaction between the teacher and the student (Kilpinen 2004). As four roles were separated, there can be more than four actors playing those roles. In this perspective, four roles are considered rather than several actors.

The design of educational software is based on innumerable decisions that are not necessarily rational, but derived from earlier experiences of designing educational software (Häkkinen 1996). The models, which are derived from these earlier experiences, might often reflect more than formal design methods, and they also reflect learning conceptualization. Hence, the subjective CoL influences the design. When designing LMS, the designers should consider the users' CoL (Joyce & Weil 1986). The possibility that their CoL could be understand from knowing theories of learning or using different learning models is considered to be useful. Also designers have their own CoL that are developed during life, as is their experience of the subject matter. Like users, designers and content producers have their own CoL. This has not yet been studied, perhaps because the field of e-learning is rather broad in scope. However, before these CoL can be studied one needs to understand what is meant by CoL.

1.4 Conceptions of learning

"I fear not the man who has practiced 10,000 kicks once, but I fear the man who has practiced one kick 10,000 times"
- Lee Jun-Fan (1940-1973).

"He doesn't have 20 years of experience, but one year repeated 20 times"
- David A. Kolb (1984, 35).

As Wittgenstein (1958) has said the meaning of a word is its use in the language. In this chapter, the term 'conception of learning' is explained to present the nature of the phenomena under this research. First, we look at the terms 'conception' and 'learning' from the semantic perspective. Then through current knowledge on perception and memory from the perspective of cognitive psychology we give an overview of the meaning for the term 'conception of learning'. Also the notion of a 'Hebbian synapse', central to modern neuroscience is discussed as a basis to understanding the physical base for conception of learning. Hebb (1949) believed that this central brain organization was essential to human mental experience.

In addition, just as Lyytinen (1987a) discusses representation forms enabled by language as important parts of object systems, we are also interested in representations when studying the conceptions. We think that conceptions serve as the basis for any artifact development and, especially in ISD, related

conceptions should be acknowledged. As science closely links human memory and learning, it is important to consider people's conceptions of learning, if effective human-computer systems are to be constructed. The computer does not suffer from memory decay in the same way as the human user does, so it can reasonably be expected to recall things that human beings would find difficult to remember. (Faulkner 1998, 47)

1.4.1 Learning and conception

The use of word conception has entailed different meanings throughout history. The word 'conception'[13] can refer to more than one meaning in different contexts (Table 2), mostly to the meaning of 'idea' or to 'fertilization' (cf. Webster 1913; Merriam-Webster Online dictionary. 2007).

TABLE 2 The different meanings of the word 'conception'

Related word	Description of meaning	Example
Concept, construct	An abstract or general idea inferred or derived from specific instances. A complex product of abstract or reflective thinking. The power or faculty of apprehending of forming an idea in the mind; the power of recalling a past sensation or perception.	"Under the article of conception, I shall confine myself to that faculty whose province it is to enable us to form a notion of our past sensations, or of the objects of sense that we have formerly perceived." – Stuart (Webster 1913)
Fertilization	Fertilization of an ovum by a spermatozoon. The act of conceiving in the womb; an embryonic animal life initiation (pregnancy).	"I will greatly multiply the sorrow and the conception." – Genesis 3:16 (Webster 1913; cf. Anon 2001)
Creation	The event that occurred at the beginning of something.	"Joy had the like conception in our eyes." –Shakespeare (2000a).
Invention, innovation, excogitation, design	The creation, originating of something in the mind. The product of a rational belief or judgment. The capacity, function, or process of forming or understanding ideas or abstractions or their symbols. Person's ideas and beliefs concerning something.	"Note this dangerous conception." –Shakespeare (2000b).

In philosophy (Mill 2007, orig. 1868b), the term 'conception' is applied to a general idea derived from and considered apart from the particulars observed by the senses. The mental process by which this idea is obtained is called abstraction. For example, when comparing several cars, the mind abstracts a certain common quality or qualities in virtue of which the mind affirms the general idea of car. Thus the term 'car connotation' being those qualities of which all cars are regarded as alike, whatever their individual peculiarities may be, is described as a concept. Or as Mill (2007, orig. 1868a, 42) explains it:

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13 The word *concipere* is originally mean as "to take in and hold" and originally meant "take (seed) into the womb", thus become pregnant. The sense of "take into the mind" is from ca 1340. (Harper 2001).

> "But here, in stead of only one, we find two distinct objects of conception: the sun is one object; existence is another. Let it not be said that this second conception, existence, is involved in the first; for the sun may be conceived as no longer existing. "The sun" does not convey all the meaning that is conveyed by "the sun exists…"

The psychic process by which a concept is affirmed is called conception, a term which is often loosely used in a concrete sense for concept itself. It is also used even more loosely as synonymous in the widest sense with idea, notion. Strictly speaking, however, it is contrasted with perception, and implies the mental reconstruction and combination of sense given data. Thus when one carries one's thoughts back to a series of events, one constructs a psychic whole made up of parts which take definite shape and character by their mutual interrelations. This process is called conceptual synthesis, the possibility of which is a necessity for the exchange of information by speech and writing. This (common) psychological interpretation of conception differs from the metaphysical or general philosophical definition given above, as it includes mental presentations in which the universal is not specifically distinguished from the particulars. Some psychologists prefer to restrict the term to the narrower use, which excludes all mental states in which particulars are cognized, even though the universal might also be present.

Learning[14], as another abstract word, refers to receiving instruction or acquiring knowledge action; especially in psychology, a process which leads to behavior modification or to the new abilities or responses acquisition, which is additional to natural development by growth or maturation. The theory attempting to account for the process of learning is called learning theory and some discussion about learning theories is needed to have an overlook of earlier research about learning.

There are many different learning theories and because there is much literature about learning theories they can be seen as rivals, situational and overlapping. The following review of learning theories is not exhaustive, but its purpose is to show that much work is needed before it is possible to compare different learning theories. As cognitive psychology investigates humans' mental functions (Thagard 1996), that is, how the human being adapts to their environment, processes knowledge and learns, this discussion about learning theories is more psychological than pedagogical. Eysenck and Keane (2000) define central cognitive actions as consisting of perception, attention, learning, memory, language, emotion, concept formation and thinking. For example, psychologists recognize two forms of learning in adults which normally go together: explicit and procedural learning (Posner & Raichle 1994, 197). Explicit learning is marked by the ability to report verbally what has been learned as a new fact. This form of learning is associated with the executive attention system operation. If subjects are distracted while they learn, they show a marked reduction in their ability to recall things explicitly. In procedural learning, people learn to perform a skill, but are unable afterward to describe the experience of learning it. And learning is much less affected by distraction.

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14 From L. *lira* (furrow, track) (Harper 2001).

In the past, research in (cognitive) psychology has been the source of most of the concepts that are used in theories of learning. Although such thinkers as Amos Comenius (1562-1670) and Johann Heinrich Pestalozzi (1746-1827) had emphasized the information acquired via perception much earlier (Vainionpää 2006). For example, in constructivism, the concepts describing learning are based on influences from studies from the period of cognitive orientation, such as Piaget (1971). However, from 1950 to 1960 research on learning was dominated by the behaviorist tendency. Although this tendency began in the early 1910s, its influences are still to be seen in the learning materials used in school today. John B. Watson (1878-1958) has been said to be the founder of behaviorism (Watson 1913). However, Edward Lee Thorndike (1874-1949) has been considered to be the father of the psychology of learning and has influenced the development of behaviorism (e.g Thorndike 1913). Behaviorism is also known as the objectivist model of learning and is mostly based on Skinner's (1935) stimulus-response theory. To simplify, the goal of teaching is to facilitate the transfer of knowledge from the expert to the learner. Although the objectivism may be the most appropriate model in some contexts and many different theories of behaviorism exist (Jonassen 1993), models challenging objectivism have emerged, from cognitive learning theory to the later developed constructivism. Constructivism denies the existence of an external reality independent of each individual's mind (e.g. Raskin 2002). The learner creates knowledge of their own. The mind produces its own unique conceptions of events. Each reality thus constructed is different, based on learners' experiences and biases. More moderate constructivists do not preclude the possibility there may be an objective world, assuming instead that each individual constructs their own image of the objective world (Yarusso 1992). From the beginning of the 1960s, the focus of learning research shifted to humans' (learners') inner functions, such as their learning processes, learning strategies and cognitive structures and operations.

The cognitive information-processing (IP) theory is another extension of the constructivist model, focusing on the cognitive processes used in learning. The cognitive conception of learning emphasizes that learning is active and creative work done by the learner. The learner interprets observations and new information based on their earlier information and experience, in other words with the help of inner functions or models (schemata). The learner takes more responsibility for their learning, while the teacher becomes a guide rather than merely dispensing information. While the IP theory is an extension of constructivism (e.g. Lehtinen et al. 1989), the sociocultural theory is both an extension of constructivism and a reaction against some of its assumptions. Learning and knowledge are situated in their historical and cultural contexts rather being seen as the mere formation of abstract concepts (Piaget 1971) to represent reality. The major implication of socioculturalism (e.g. Lave and Wenger 1991) is that students should participate on their own terms.

Recent learning theories include constructivism (Bruner 1966), socially shared cognition (Resnick et al. 1991), sociocultural theory (Rogoff 1990), social development theory (Vygotsky 1978) and situated learning (Lave 1988).

Expansive learning (Engeström 1987) and explorative learning (Hakkarainen et al. 1999) are other approaches currently being discussed. Also metacognitive skills are seen as important assets in learning, for example, when learners themselves are directing their e-learning. Nevertheless, no particular theory has yet been accepted as the best approach, as the most significant theory or model of learning, perhaps because this lies in conceptions of the human being. As the human being is always in a state of development, their conceptions are transient, changing dynamically and turning into new conceptions. Thus, CoLs are evolving all the time and new theories are going to arise. However, this discussion about dynamic learning theories will be continued elsewhere because research on learning is a rapidly and constantly developing area of education. Instead we next look more deeply into the physical part of learning.

1.4.2 Learning and perception

The psychological theory of learning emphasizes the only condition necessary for stimuli and responses association: a close temporal relationship between them. It holds that learning will occur regardless of whether reinforcement is given, as long as the conditioned stimulus and the response occur together. The perceptual process can be separated into seven steps (Goldstein 1999, 2): distal stimulus, proximal stimulus, transduction, neural processing, perception, recognition and action. In the perceptual cycle action precedes proximal stimulus. Thus the process of perception is changing the dynamic process.

In vision, the distal stimulus is a stimulus[15] from the environment, for example, an object. Proximal stimulus is an image on the receptors[16] (retina) that line the back of the brain. Transduction is the light of the proximal stimulus transformation into electrical signals. Neural processing is the operation that transforms the electrical signals in the networks of the neuron, and perception is created by a flow of signals through nerve pathways. Recognition is an ability to place that object in our vision in a category that gives it meaning, and action follows perception and recognition. The seeing of objects involves many sources of information beyond those meeting the eye when we look at an object. It involves knowledge of the object derived from previous experience, and this experience is not limited to vision, but may include the other senses: touch, taste, smell, hearing and perhaps also temperature or pain.

The operation of all the senses is governed by similar underlying principles, for example, the skin and the retina. There are center-surround receptive fields on the retina and center-surround receptive fields on the skin (Goldstein 1999, 301). Even though the perceptual process may be complex,

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15 Light (electromagnetical wave) perceived by a human can be 397-723 nm in length. The light which is perceived can be from a direct source or from reflecting and folding planes. It contains information about the object's size, color, distance and position among other objects.

16 Humans have over 100 million rods and over 5 million cones. It only requires one photon per receptor cell (rod or cone) to ignite transduction. The minimum intensity of light required is 1 candelas and the maximum is 10^{12} candelas.

different mechanisms of perception can be categorized into four categories (e.g. Gazzaniga et al. 2002): 1) Vision, consisting of visual qualities like color, form, depth, size, and movement, 2) Hearing, containing recognition of pitch, localizing sounds in speech and perceiving speech, 3) Cutaneous senses, consisting of the perception of touch, pain and temperature and 4) Chemical senses, consisting of the function of taste and smell. There is also in some sense, the somasensory system, which includes, for example, proprioception and kinesthesis (sense of position and movements of limbs). This could be also considered as one mechanism of perception.

1.4.3 Learning and memory

"You have to begin to lose your memory, if only in bits and pieces, to realize that memory is what makes our lives. Life without memory is no life at all...Our memory is our coherence, our reason, our feeling, even our action. Without it, we are nothing."
-Juan Luis Buñuel (1900-1983).

Memory, here as a concept, is used to describe the ability of an organism or artifact to record (coding, consolidation), store (maintenance of memories) and restore (search, managing cognitive actions) information within the brain. To provide some perspective, Landauer (1986) estimated that people take in and remember only about a byte in a second, but they read about 3 to 5 words a second that is about 600 KBytes or 300 pages a day within 8 hours (36600 s).

The brain itself is the part of the central nervous system that includes all the higher nervous centers and contains approximately 10 billion nerve cells. From the current cognitive science perspective (e.g. Eysenck & Keane 2000), learning and memory are considered to be based on the chemical and neurological changes in the brain. One important microlevel phenomenon in brains for learning is the synaptic strengthening produced by long-term potentiation (Gazzaniga et al. 2002). It is found and shown within the hippocampus that, the postsynaptic response is stronger if the presynaptic stimulation is recurrent and if the brains theta-frequency activity is 4-6 Hz. This means that the information is well stored into the memory, or described as terms of successful learning. Thus, repetition with a certain brain frequency activity has effects on the connections between human neurons, thus on our memory. As memory is the most central cognitive function (or skill) for human action, there would be no learning without the memory. However learning is not the same as having memory, because learning changes the content in memory. And, by observing behavioral and neurophysiological changes it is possible to study learning, but memory is cognitive level phenomenon.

The architecture of the memory is considered to consist of a working memory (short-term memory, STM) and a long-term memory (LTM) (Gazzaniga et al. 2002). The sensory memory connects the perception and the memory together by keeping the sensory information as long as (est. 0,5-5,0 s) a human can interpret it in STM. This process contains modal-specific coding, and the capacity to deal with different information is high (content of the

perceptual area). Working memory consists of three separate parts (Baddeley's 2000): central executive, visuspatial sketchpad (working with visual semantics), episodic buffer (episodic LTM) and phonological loop (keeping language content in STM). The central executive manages resources allocation, recording information to the LTM and retrieval information from the LTM according to the meaning of the content and the aims. The working memory is the only memory part which we can self-observe (consciousness) and the capacity of the working memory is limited. Information can be kept (3-7 chunks[17]) in the working memory as long as we are working with that information (usually 10-30s). If the information is not repeated or practiced, it will not be transferred to the long-term memory. Coding is based on the information validation from the sensory memory content, managed by a state of attention or awareness. Moreover, that information is connected to the information in the long-term memory. This is also called chunking. As described earlier, the LTM is used to give meanings and explanations to our actions. It is the space for that information (skills, memories), which is not used constantly, but is needed to understand the present. The LTM is believed to have no limits and the information which is once stored into the LTM stays there as long as the brain is functioning well (Gazzaniga et al. 2002). However, we are not conscious of the information in the LTM, until that information is retrieved into the STM. The architecture of the LTM consists of episodic memory, (life events, stories: what, when and how it happened) and datamemory (facts, data, associations). According to schema-theory, the information in the LTM is organized according to schemata (internal models). We form internal models from the phenomena of our environment. These internal models are not copies of the phenomena, but interpretations which will aim at the perception (apperception) and processing of new information. The important issues for us will be emphasized and not so important issues will get less attention. Thus, the interest will guide the formation of internal models.

The endeavor to understand things, to find meaning, is central to the function of our memory. Learning is effective when internal models are continuously improved upon and when there is easy retrieval of that model (well structured and condensed) into the STM. This will happen when information is actively and continuously organized and processed. Most probably the effective memory consists of well organized internal models, meaning physiologically probably well connected neuron cells. Thus, memorizing would be reconstructive, continuous and creative action within the brain and learning as a continuous journey of changes into our mind and to our world view, not yet fully understood (e.g. Patterson 2007). For example, Gazzaniga et al (2002) suggested that education should be about discovering what a given person's brain allows them to learn and then concentrating their learning in the areas of strength. And, this discovering would be personal as the anatomy of the human brain sometimes differs from one person to the next, for

17 units of meaning (Miller 1956).

example, in the distance between the locations of the same functional area (Posner & Raichle 1994, 232).

But, one could overstate the idea that the brain prepares us for talents in different directions, thus envisaging a cognitive neuroscience of the future, where one is able to discover the latent talents in different brains. One could then design the educational experience that would enable individuals to best develop those talents. However, if those people want to do many other things, it is questionable if they can be experts. Research in these areas emphasize the long period of training necessary to become an expert in some domain, suggesting that great expertise is available to anyone who is willing to obtain the appropriately elaborate memory store (Posner & Raichle 1994). This view that everything rests on training, is in opposition to the view that everything rests upon the initial structure of the brain. In the latter case, those people become multi-experts who hold discussions with different super-experts. On the other hand, if just experts are wanted, then some expert-clones, robots, or cyborgs should be produced, because they could be designed to have faster information processing and retrieving capabilities.

1.4.4 Conceptions, thoughts and mental representations

Mental representations are the internal systems of information used in perception, language, reasoning, problem solving, and other cognitive activities (Billman 1998, 650). In 1949, Donald O. Hebb (1904-1985) presented an exciting integration of mental and brain processes. Hebb provided the first testable theory of how neural circuits might support mental processes such as attention and memory (Posner & Raichle 1994, 6). The main point in Hebb's theorizing was "cell assemblies," an idea that remains a major conceptual force in theories of brain functions. The thought was that any frequently repeated simulation would lead to a structure development consisting of neurons acting together as a closed system. However this closed system was scattered, thus the neurons in a cell assembly were not located in a single place, but scattered throughout the brain. Hebb also argued that mental representations of perceptual experiences could be built up based upon these cell assemblies' actions. For example, the mental representation of a triangle was made up of multiple cell assemblies each concerned with a different element of the triangle. Different elements of triangle could be derived from successive visual fixations of the triangle's vertices and different cell assemblies would represent different views of the triangle. Consequently, the neurons in a cell assembly were able to act together because of changes in the synapses between them.

However, information from multiple assemblies would have to be coordinated for a unified perception to occur, much like polling the views of people standing at different positions around a dog. Hebb postulated a hierarchical structure of cell assemblies, because of this need for information coordination (Posner & Raichle 1994, 6). The Hebb conception was that the cell assemblies at the bottom of the hierarchy might respond to individual parts of

perceived object, and the higher-level assemblies to the complete figure of object. Eventually, through a learning process affecting the strength of connections among the cells of various assemblies, a mental image, mental representation, might be built in the brain that was independent of any particular external experience. After formation, a network of cell assemblies would respond to a wide range of objects similar to the perceived object, varying size and shape.

According to Posner and Raichle (1994) later in the 1950s and 1960s scientific work confirmed that there is a specific region of the brain specialized in processing information from each of the visual, auditory and other senses. For example, light reflecting off a target strikes the cells of the retina, which transmit a signal to the primary visual area (retina) at the back of the brain (Posner & Raichle 1994, 9). Cells specialized to detect lines of the same angles as those on the target will fire rapidly, producing more vertical lines, or "spikes", in an electrical recording. And, cells specialized for lines of other orientations will fire only occasionally (few spikes). In addition, Konorski (1967) described the existence of special pattern-sensitive neurons as the basic building blocks of recognition and afferent systems which are built hierarchically, higher levels being functionally superimposed on the lower levels and receiving from them messages ultimately originating at the receptive surfaces.

Based on a finding in neuroscience, there is a general agreement that in sensory and motor systems a specific analysis, an operation, is performed by a precisely located network (e.g. Gazzaniga et al. 2002). However, when processing an object's motion, for example, the scientist must have identified the specific brain region, but does not know how these cell assemblies in that area calculate the speed and directions of movement. Perhaps there is another region in the brain or a system, not yet found, which connected to these cell assemblies adds to the speed and directions of movement of perceived object. Or possibly higher-level cognitive processes do not have defined locations. Thus, there is no verification of where these locations would be, since the methods of neuro-imaging cannot "see" below several millimeters. There is a gap between understanding human mental operations to neural systems. (Posner & Raichle 1994, 231). Also one other aspect should be considered - we are unique. As the anatomy of the human brain sometimes differs from one person to the next, such as distances between locations of functional area in different brains, anatomical landmarks may be missing in some normal brains. Furthermore, individuals may differ in the strategies they apply to even relatively simple tasks like reading or remembering words. Despite clever warping algorithms and careful attention to behavioral detail, variability will remain. For example, in the micrometer range, the primary visual cortex of each monkey looks different, like an individual fingerprint. When considering that individual identification can be more than a simple fingerprint, or biometrical identification, the detailed cognitive maps of individual would lead to a more precise identification of a person.

As modern understanding of the basic building blocks of biological systems becomes ever more refined, it becomes clear the mental activities

surrounding consciousness, perception and thought are the result of multiple assemblies of cells within the brain. However mental images are still the ultimate in the subjective (Anderson 1998, 204) and the images generated in one person's mind cannot be directly experienced by other people or compared directly with images generated by different people. It is not clear if imaging before action would enhance the action, but neuropsychological evidence is consistent with the presumed links between visual perception and visual imagery (Gazzaniga et al. 2002). For instance, the primary visual cortex is activated when people imagine objects with their eyes closed. Among other things, visual perception allows us to inspect, reach for, and manipulate objects, as well navigate in space. Studies have demonstrated that a visual image is analogous to a visual percept, in that it can be used to represent and process information about object properties and spatial relations.

As a summary, we think, learn and visualize things. For example, during the learning process, as cells developed into an assembly, the used connections became stronger, so even a weak signal from one neuron would suffice to activate the next one and so on. This means that when one neuron in the assembly is activated to "fire" an electrical signal, all the other cells might fire as well. Perhaps, strong mental representation, assembly of neural cells perceived in higher mental state, is a more than eligible aim, perhaps it is the reason for the executed action or this is an assumption of folk psychology (e.g. Stufflebeam 1998, 638). In the case of the latter, more in-depth consideration and study might help to better understand the complex, yet interesting convergence between mental representations, perception and conception of learning.

1.4.5 Earlier and future conceptions of learning

"Rather than being a process of acquiring something, as commonly depicted, learning is in fact a process of becoming something. Learners do not 'receive' information which they then 'store', they gain experiences which, over time, result in the formation of neural structures. To learn is to instantiate patterns of connectivity in the brain. These connections form as a result practice and experience. They are not constructed; a student does not 'make meaning' or 'construct meaning', as sometimes depicted in the literature. Connections are grown, not created; meaning is, therefore, grown, not constructed."

- Stephen Downes (October 18, 2007)

Shuell (1986) describes well how research on learning changed from emphasizing the cognitive side more than the behavioral side of learning. During the 1960s, research on learning began to undergo a change. The debate about whether classical conditioning and operant conditioning represent one or two different types of learning (Kimble 1961) was extended by Gagné's (1965) postulation of eight types of learning. Later Gagné condensed these eight types into five learning outcomes (intellectual skills, cognitive strategies, verbal information, motor skills, and attitudes). Recent research (Säljö 1979; Van Rossum et al. 1985; Marton et al. 1993; Marton & Booth 1996; Cliff 1998; Isomäki

& Häkkinen 2001; Illeris 2002) describes CoL using a type of hierarchy or by classification. For example, Isomäki and Häkkinen (2001) summarize the IS designers' eight different CoLs: action, affective, formal, temporal, demographic, technology-driven, contextual, and simultaneous learning.

Clearly earlier CoL (Appendix I) have been beneficial for discussion and further development of new CoL. Although CoL are semantic descriptions, and sometimes pragmatic descriptions of certain issues that cannot be recorded, human brain functions can be studied in a detailed level (Posner & Raichle 1994, 24). It is most likely that CoL will change. Because of: 1) new knowledge about human consciousness and memory, 2) problem solving skills for experts development are emphasized, 3) research has shown that young children already have skills and tendencies which need to be considered when designing instruction and learning situations, 4) increased information about learners' metacognitive skills, and 5) learning seems to be a social process which happens in societies with certain rules (Bransford et al. 1999). As future research reaches a more detailed description of human learning and cognition (Posner & Raichle, 1994, 236 & 244) it will change the educational systems and educational technology development, including LMS.

2 RESEARCH

2.1 Research motivation

"Basic knowledge acquired through education develops through experiences to a personal wisdom of things and circumstances. Our decisions are based on to this wisdom (or nonwisdom), available information, conceptions about abstract and nonabstract issues and most likely based on our emotions"
- Herbert A. Simon (1916-2001).

Despite the idea starts up a study, there is a certain state of affairs occupying our mind before it, questions to which we want to find answers (Järvinen 2004, 3). Finding some answers to those questions is considered to be the general motivation for this research. However, as the mind (referred to as intellectual capabilities) cannot explore many questions at once, an identification and definition of the most important one is needed. Besides having answers to the research questions, goals and decisions are presented as important motivation for the research, because for us to find an answer to the research question is to make a decision to set a certain goal in research.

Referring to Newell and Simon (1972), a "problem space" was first created and then that problem space was in need of divide-and-conquer actions to keep cognitive conflicts[18] and decisions at hand. It is important to notice here that as cognitive conflict increases, emotional arousal increases. This can narrow the focus of attention. In high levels of cognitive conflict tunnel vision is developed to the point where important considerations are ignored more likely. Indeed, the moderate levels of cognitive conflict are found to be the most conductive to good decision-making. As stated, decision-making is goal-oriented action, where easy and low-level goals can precede easy and low-level decisions and low cognitive conflict and vice versa.

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18 Cognitive conflict relates to the amount of uncertainty about the consequences of various alternatives and the importance of those consequences (Anderson 2002, 14).

The related goals and decisions made for this research are explained, before presenting the research questions. Goals and decisions are considered important to realize the description of the research questions and research method. Thus, research is a goal-oriented conscious or unconscious decision.

2.1.1 Goals

For those with goals (Schank & Abelson 1977, Table 3 below), achieving those goals bring them joy and fulfillment. Ortony et al. (1988, 41) used categories to describe these goals as Active pursuit goals (A-goals, things one want to get done), Replenishment goals (R-goals, things one want to engage) and Interest goals (I-goals, things one want to see happen). It is clear, that related to this research, there are ARI-goals which are sub-goals to the main research goal, which itself is an instrumental goal.

TABLE 3 Human goals

Goal	**Purpose of the goal**
Achievement	To achieve certain things
Satisfaction	To satisfy certain (biological) needs
Entertainment	To enjoy certain things
Preservation	To preserve certain states of affairs
Crisis	To handle crisis when preservation goals are threatened
Instrumental	To realize other goals

When speaking of emotions, sub-goals can be summarized as the variables associated with reactions to events (desirability, computed about goals), actions of agents (praiseworthiness, computed about standards) and objects (appealingness, evaluated by attitudes). For example, if someone with the appropriate tunnel vision has becoming a professor as a goal - to achieve this goal, there is usually a sub-goal – the need to get a doctoral degree. The desirability of a doctoral degree is determined by its relation to its subsuming goal, imposing an upper limit on its desirability. If the only purpose of getting a doctoral degree is to become a professor, it cannot have greater desirability than that of becoming a professor. Thus, desirability is similar to (subjective) intrinsic value and is accordingly independent of the (anticipated) effort. Effort, on the other hand, depends on what one does to achieve one's goals. Effort relates to the implementation and execution of the plans to achieve the goals, rather than to the goals themselves.

On the other hand, one of the most fundamental goals in life is considered to be that of being happy. For example, according to one study, Americans considered happiness more important to them than money, moral goodness, and even going to Heaven (King & Napa 1998). Frank (2004) argues that the less people spend on conspicuous consumption goods, the better we can afford to alleviate congestion; and the more time we can devote to family and friends, to exercise, sleep, travel, and to the other restorative activities. Thus, subjective

well-being (Ekman et al. 2005) will be higher in the society with a greater balance of inconspicuous consumption. Moreover, according to Argyle (1987), to enhance happiness, one should get married, stay married, have children, keep in touch with relatives, have plenty of friends and be friends with the neighbors. It seems that if the goal is to be happy, we should foster social relationships (Kahneman et al. 2004) more with home, friends and close people than in other contexts. However, currently social networking is emphasized as part of sharing knowledge and developing expertise in the workplaces.

From another perspective, happiness can meet all reasonable criteria for a psychiatric disorder (Bentall 1992). Thus, if one of the human fundamental goals is considered to be a psychiatric disorder, the other goals may also be. However, we conclude that every region in the brain that has been identified with some aspect of emotion has also been identified with an aspect of cognition (e.g. Davidson & Irwin 1999). It seems that towards goals in human cognition, emotions are present and need to be considered. For example, Buddhist practitioners have developed and tested ways of gradually cultivating those emotions that are conductive to the pursuit of *sukha*[19] and of freeing themselves from emotions detrimental to that pursuit (Ekman et al. 2005).

2.1.2 Decisions

To set a goal or not is a decision. According to Simon (1979), organizations are moving in the space of decisions from one decision to another with the help of something like a planned guide (including goals), thus through that knowledge which organizations have gathered via their existence. In addition, decisions are partly based on that gathered knowledge. In life, it is not always possible to acquire all the necessary information needed in decisions, but organizations should be able to react to the changes within the environment. Thus, decisions are also based on beliefs, intuitions and emotions.

Through education we learn that human beings decide with the help of rational thinking and intuition. Yet at the same time there are many unconscious decisions made that we do not acknowledge. For example, in nonverbal communication we do not always decide to smile. Thus it is important to consider how significant the decisions are that we are making, and what decisions lead us to the decision-making. The decisions we make are not always logical; one could even say that sometimes they are random. Nevertheless, decisions also force us to think ahead and thus more problem-spaces and decision-making situations will become available.

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19 In this context as a state of flourishing that arises from mental balance and insight into the nature of reality (Ekman et al. 2005).

2.2 Research framework

A framework (Khan 2001) consisting of eight perspectives (pedagogical, technological, interface design, evaluation, management, resource support, ethical, and institutional) into e-learning was used as the starting point for the research. Khan's framework helps designers to think through every aspect of what they are doing, during various steps of the e-learning development, including LMSD. It can be used to ensure that no important factor is omitted from the design of e-learning, whatever its scope or complexity. It can guide in the design, design, evaluation and implementation of, for example online courses and LMS. This research concentrates on the pedagogical, management, institutional and technological perspectives.

Research on designer's, teacher's and student's CoL (e.g. Häkkinen 1996) presents some instructional and methodological approaches for this research. Earlier research work (e.g. Isomäki & Häkkinen 2001) on human centered technology and learning presents a significant contribution when an analysis of designers' conceptions was done. The connection to the human-centered view is clear because the LMSD involves a continuous social and physical construction of a design artifact (Häkkinen 1996). The research target was the CoL of stakeholders of LMSD, especially the designers' and content producers'.

2.3 Research question

The research questions (RQ) concerning LMSD are based on the two hypotheses: The first (H1) was the stakeholders' different associations of CoL influencing the LMSD. The second (H2) was that if the CoL are different from the created artifact, LMS contain components which present and support only certain CoL. After gaining more experience and knowledge about the research context, LMSD, the following research question (Q1) was formulated: What are the stakeholders' CoL in LMSD? This research question was found to be appropriate and important as there is research about designer's, teacher's and user's CoL (e.g. Häkkinen 1996; Patrikainen 1997; Isomäki & Häkkinen 2001), but no research on content producers' CoL. To find answers to this question leads us also to search for similarities and differences between those conceptions, if any. The research sub-questions (Q2&3) were about the influence of individual CoL on LMSD: In LMSD, does the stakeholders CoL interact (Q2) and what CoL are used (Q3)? The Q2 can also be pointed out indirectly. For example, the end users do not always use the software as expected by designers but reinterpret its original functions (e.g. Hativa 1994).

The first problem was to define the conception of learning, because it was the research target and base for estimating the proximity of point of views. Second, there was a need to understand LMSD so the development group

(designers and content producers) could understand the questions that were developed. After these issues, some research work directed at the stakeholders of LMSD was needed. It required becoming acquainted with the target system, LMS and the environments where it was developed, the e-learning companies. Finally, it was acknowledged that CoL cannot be fully represented. Just as IS representations include various non-structured and semi-structured representations such as conceptual models, hypertext documents, free-text or video (Kaipala 2000), conceptions (cf. 1.4.1) are multi-structured mental representations. However, conceptual models allow more precise syntax and semantics to be incorporated into IS representations than informal text representations (Hirschheim et al. 1995). Understanding some conceptions makes it possible to compare them against each other at a certain level. Furthermore discussions with the target group can give more detailed explanations.

2.4 Research methodology

Research can be categorized from multiple perspectives, for example, with a research approach, such as a subjectivist and objectivist approach (Burrell and Morgan 1979). This categorization is based on differences in ontology, epistemology, human nature, and the research methodology or method used. The subjectivist approach considers reality to be constructed through human actors and maintains that the social world can only be understood by people involved in the focus area of the study. The objectivist approach considers the social world as the object independent of humans, and stresses systematic research techniques for explaining and discovering regularities, patterns of actions, and causal relationships (Järvinen 2004). This research is subjective, because it approaches the research target considered common to all human beings by involving those actors' activities. And it is also objective, because it cannot explain the results without the targets or human actors, but needs to stress the regularities among different CoL.

Orlikowski and Baroudi (1991) have proposed a categorization into positivist, interpretive and critical research approach. According to Järvinen (2004) the positivist approach category of Orlikowski and Baroudi (1991) is akin to the objectivist approach, and the interpretive approach category is closely related to the subjectivist approach. And the critical approach category may favor longitudinal studies. From this research perspective, this relation is interesting, but maintains the notion that the categorization the approach of this research depends on the perspective.

In another perspective, according to Galliers (1991), a research approach is a way of going about one's research. An approach may embody a particular style and may adopt different methods or techniques. These methods instantiates can also be used for research categorization. The method consists of

directions and rules of action according to some systematic ordering (Hirschheim et al. 1995). A research method may be considered as a procedure or mode of inquiry, which consists of intertwined or integrated techniques as procedures of actions (Blokdijk & Blokdijk 1987, 5).

This research was divided into separate phases. The research methods used were phenomenography with a pilot case study and a survey. Using all of them in this research is described briefly, in the following paragraphs and results as categories of descriptions. Let it be noted that a pilot case study here is a descriptive single case study, not a theory-testing case study, and the survey method is more a theory-testing, than theory-creating approach. The set of the different research methods used form together a research methodology. Thus, designers' and content producers' CoL were studied first with a pilot case (interviews), and then data was collected from them using a web-survey.

2.4.1 Use of Phenomenography

Regarding the first research question (3.2), phenomenography (Marton 1975, 1981, 1998; Marton & Booth 1997; Marton et al. 1993) is a notable method for this research. Developing phenomenographical theory is drawing on the notions of consciousness (Gurwitsch 1964, 1970) as elaborated by Aron Gurwitsch (1901-1973), but it is also said to have emerged from an empirical rather than a theoretical or philosophical basis (Åkerlind 2005). With phenomenography the human conception of certain phenomenon is studied, the qualitatively different ways in which people experience something or think about something (Isomäki 2002; Järvinen 2004; Renström 1988). Phenomenography is a qualitative research methodology and it contains phases such as theoretical study, problem-setting, data-collecting, and interpretive analysis. In phenomenography, there is a subjectivist ontological assumption: Only one world exists and different people construct it in different ways. There is also a need for description, understanding of knowledge meaning and similarities and differences in meaning (Svensson 1997).

Phenomenography usually contains the following phases: 1) a phenomenon of which people have different conceptions is selected to come under study, 2) this phenomenon is theoretically studied and those issues related to that are organized (e.g. mind mapping), 3) people are interviewed about this phenomenon, and 4) people's conceptions are classified according to their meanings. Different meanings are explained by constructing abstract categories of descriptions (e.g. Järvinen 2004, 82). The categories of descriptions are sometimes referred to as an 'outcome space' and are the primary outcomes, and the most important result of phenomenographic research. Categories of descriptions are logically related to one another, typically with hierarchically inclusive relationships, although linear and branched relationships can also occur (Åkerlind 2005). The variance between different categories of description is known as the 'dimensions of variation'. The phenomenographic analysis is strongly iterative, involving the continual sorting and resorting of data. It is also

comparative with ongoing comparisons; between data and the developing categories of description, as well as between the categories themselves.

In this research these four phases of phenomenography were conducted. First the phenomenon was outlined from the reality to be observed (CoL). Then the viewpoint was limited (designers' and content producers' CoL in LMSD). In order to organize and collect information about the phenomenon under study, research literature about essential or related concepts was studied (Articles 1 & 3). Next, a pilot case study was conducted (3.3.2, Sievänen 2004), where a method for this research (Article 5) was presented. After the pilot case study, a web-survey was planned for extracting stakeholders CoL. The questionnaire included structured and non-structured questions. The results from a statistical analysis (structured questions) and text analysis (non-structured questions) were finally written into descriptive categories.

2.4.2 Use of case-study

The case study was integrated in line with phenomenography, as it was seen as a descriptive and theory-creating research method. According to Eisenhardt (1989) a case study is the appropriate choice, when the research interest area is new and/or less studied. With a case study, the researcher can find structures of conceptions, models or even theories of what is the world like. A case study can include just a single-case or multiple cases. In this research, the case study was used as a single case study, studying stakeholders' CoL and conducted as Eisenhardt (1989) has presented it. First, the research question was defined, Q1, then the data was collected using interviews. The targets were a male designer and a female content producer from different organizations. Based on observations and an analysis of collected data, some generalizations were made rather than a theory. For example, from a case study, a result could be a sketch hypothesis. Comparing this hypothesis to theories against and mutual to it could raise the entire research's internal validity, theoretical level and sharpen the definitions of the concepts. In our case, the first hypothesis was tested and the definitions of the concepts sharpened.

Yin (1989) proposes the use of test cases before the actual case study. The conducted test case in this research tested research tools (questionnaire) and method itself (explanation building). It is also important to note that in a single case study one should pay attention to several features. When the greatest number of information resources is used, the contradictions and objections can then be more easily managed. Conclusions and results could be explained by giving examples and details from the information resources. Important resources with this method were interviews, but also other data resources, for example, development documents, archives, free observations, engaged observations and artifacts. As from a small research sample it is difficult to get enough quantitative data, both qualitative and quantitative data can be used as evidence in empirical approaches (Yin 1989).

2.4.3 Use of survey

Kraemer (1991) discusses that in survey studies, questions are structured. They are conducted from a theory, a model or from a theoretical framework. As mentioned earlier, one of the most influential works for this research was Häkkinen's (1996) work with teachers', designers' and users' involving e-learning environments. A survey was chosen, because structured questions could be made from previous work and discussions with the field (Cunningham 1997). The survey was conducted with the help of knowledge from survey guidebooks (e.g. Fowler 1988; Fink & Kosecoff 1985; Bradburn & Sudman 1988; Marsh 1982) and other resources (e.g. Survey Instruments repository). The survey's target was a convenience sample of LMS designers and content producers, and was done in the form of a web-survey.

2.4.4 Use of all three research methods

The three methods were used to study the phenomenon of interest, aiming for combined results from different approaches. In Figure 1 (at the end of 2.5), the different methods are presented as related to the appearance during the research. Because the research question was about people's conceptions, the whole period was considered to be one phenomenography, which is supported by the result from the case study and survey studies. The case study with one development organization first produced a better starting hypothesis, sharpened concepts and enhanced questionnaire for use in the survey. CoL were gathered by involving as many organizations as possible in the survey. Theoretical argumentations were used with three methods, because certain questions can be traced from the studied issues related to context and needed to be studied and answered before going further into the research.

In order to gain, a better understanding of the relation between theory and reality, the use of ethnography was also studied at the beginning of this research, as was testing and evaluating the theory, even though ethnography is used mainly for creating theory. However it is perhaps the most suitable method to generate a fair amount of heterogeneous data. Using ethnography for this research would have meant getting involved in the LMSD. This would have been done, for example, by working with designers and content producers in a target company. However, Van Maanen (1979), talks about making a distinction between first and second level conceptions. In this research it means that first level conceptions are people's discussion topics like the development process, facts presented about users, and talks about their educational background and work. Second level conceptions would be those that answer to our research questions and would be concluded from a collected data analysis. Data should be collected without bias, and after a short period of time it should be analyzed and explained, as CoL are time-dependent. Analysis requires good notes during the intensive time period. Due to the limit of the available resources, the fourth method was omitted.

2.5 Research methods and the articles

This research consisted of several phases. An overview of how different articles are related to the research methods is presented. The focus and the target context for each article are presented in Table 4 below. The articles included in this dissertation are numbered from 1-6 and were published during the different phases of the research (Figure 1). Some articles were created to make the research domain and target more understandable (Articles 1, 3 & 4), and also because of the fact that, the research work and results (Articles 2, 5 & 6) were dependent on the input of others. The name of the articles, the research methods and the results are presented in the next chapter.

TABLE 4 Research articles' focus.

Nro	Focus	Phenomenography part	Context
A1	Reasons for enhancing LMS	Study of issues related	e-learning, LMS
A2	Roles in LMSD	People involved	Stakeholders
A3	LMS space-place transition	Study of issues related	LMS
A4	Description of design work	People involved	LMSD
A5	Method development, CoL categorization	Classifying conceptions	Stakeholders' Col
A6	An agent based approach to LMSD	Study of issues related	LMSD

The first phase consisted of studies of earlier research and the theoretical background of conceptions, CoL, learning theories, IS, LMS, ISD methodologies and processes. Articles 1 and 3 mainly discuss through theoretical argumentation about the issues raised from the earlier research and from the research collaboration during the research period. Thus, these papers discuss about possible areas in LMSD which have an impact on future research and on the use of LMS. Data from the first interview (Sievänen 2004) was used to become familiar with the domain and part of it is presented in Article 4. The methodological tool for mapping different conceptions described in that paper was constantly developed during the research. In Article 5, this development is reconstructed and synthesized, to give birth to a model. Article 2 presents results conducted from a web-survey and a quantitative analysis. Article 6 presents an approach for LMSD based on the research findings and research about agent technology.

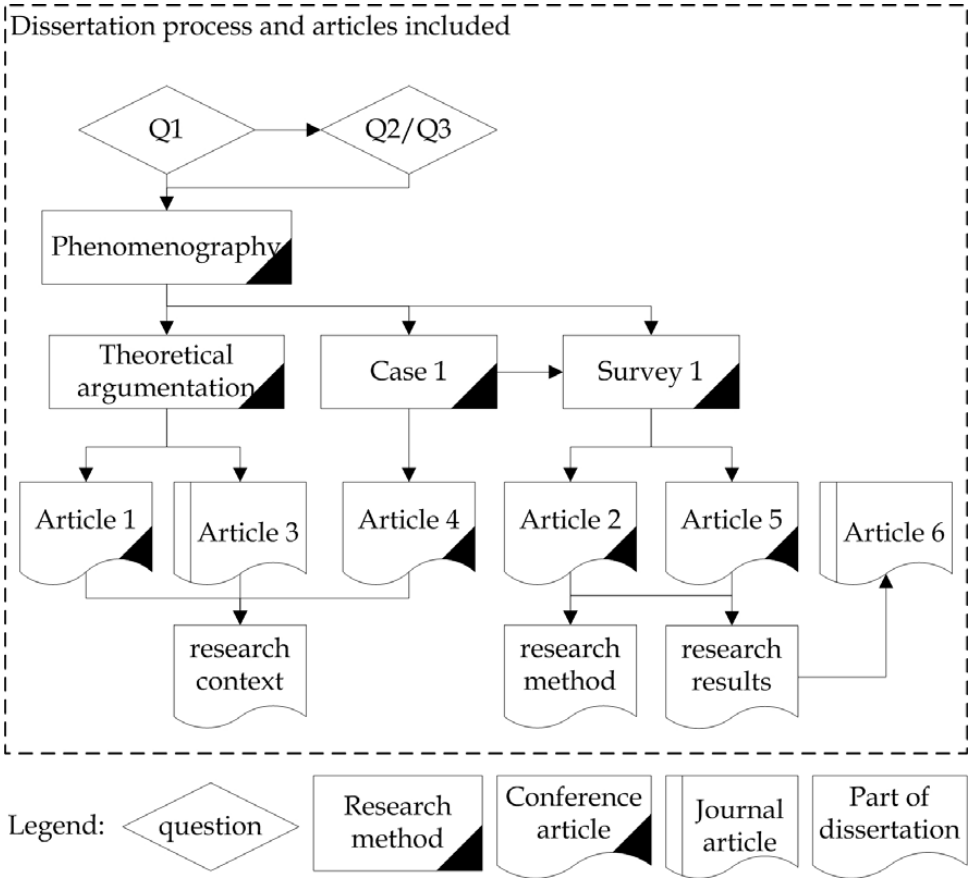

FIGURE 1 Research questions, methods and articles linkages

3 OVERVIEW OF THE ARTICLES

In this chapter, a short summary of each article for this research is presented. The publication details of the papers and authors are listed for each paper. The order of the papers is logical, not chronological, following the order presented in Table 5. The overview of the articles consists of summaries of the research conducted, method used, the main findings and brief discussions of the findings. In addition, the limitations and validity issues of the studies are discussed. The finding are summarized at the end of the chapter and discussed in the next chapter (chapter 4).

3.1 Article 1: "Over 283 693 Reasons to Elaborate Education, Work and Apply E-learning"

Wahlstedt, A. 2006. Over 283 693 reasons to elaborate education, work and apply E-learning. In E. Cohen (Ed.) Proceedings of the Informing Science and Information Technology Education Joint Conference. Santa Rosa, CA: Informing Science Institute, 299-305.

The idea to study, what are the reasons for elaborating education and apply e-learning and further use of LMS, was pondered for a long time. There was a need to justify the motivation for an LMSD effort. The research method was theoretical argumentation with data analysis from the data from the national databases on Finland's population and education in 2004. The conclusion from this study indicated that there can be many reasons for LMSD. In this study we concluded that e-learning can aid in distributing economic growth by making advanced learning opportunities accessible to potential and motivated learners over cultural and spatial boundaries. Based on the evaluated data, the economical factors should not be superior reasons when justifying the further utilizations of e-learning for children and people who want to educate themselves. Within this study, children were emphasized as the foremost reason for LMSD. To overcome the education challenges, studies where young

people participate in LMSD and where there is collaboration between stakeholders, was proposed. That helps administrative decision-making which does not prevent the possibilities for children to learn and educate themselves in a secure and familiar place. However, during this research, it was found that the participatory to the design and decision action are limited by expertise level.

3.2 Article 2: "Roles in Learning Management Systems Development"

Wahlstedt, A. 2006. Roles in learning management systems development. In M. Khosrow-Pour (Ed.) Proceedings of the International Resources Management Association (IRMA) Conference "Emerging trends and challenges in information technology management". Hershey, PA: Idea Group, 522-524.

In this study, the focus was to present the cooperation between various professionals in LMSD as having roles. The analysis in this study was based on the web-survey data and the results show that the stakeholders of LMSD identified roles related to their work. These roles are beneficial, because stakeholders can identify the other stakeholders according to their roles. By cooperating with other stakeholders, knowledge may increase. The role definitions give the stakeholders a hint of who might help increasing information richness. In addition valued users are the key to the success of systems development. However, LMSD stakeholders mostly described their roles of content producers, developers and designers, but least as users. We also reported emerging roles in LMSD found in this study. In general, emerging roles involve different responsibilities depending on the phases of the LMSD.

3.3 Article 3: "From e-learning space to e-learning place"

Wahlstedt, A., Niemelä, M. & Pekkola, S. From e-learning space to e-learning place. British Journal of Educational Technology. To be published.

In this study, we presented different prerequisites, preconditions and methods to support the transformation from space to place. The initial idea to explore this issue emerged during conversations with Professor Samuli Pekkola and Doctor Marketta Niemelä on a train trip to a national conference. During further discussion together, we elaborated the idea suitable for the article. The concepts of space and place were used for concretizing an argument concerning e-learning environment (as LMS). Professor Pekkola organized the paper and bring the idea of using theoretical argumentation as suitable method for this study. Doctor Niemelä contributed to the paper from the User psychology point

of view and made lot of enhancements to the paper. The writing of this article was a long iterative process and all authors gave an equal amount of effort to finalize the article into its final form. The article presents that when focusing on making LMS as a place for learning, there emerges a need for designing support for social interactions. A result from the theoretical argumentation was that by shifting the LMS design towards a design for social interactions, LMS adopt environmental and social characteristics. Thus, LMS becomes more a place of learning – but still without physical restrictions.

3.4 Article 4: "The Time and the Design of Web-Based Learning Environment"

Wahlstedt, A. (2005). The time and the design of web-based learning environment. In E. B. Cohen (Ed.) Issues in Informing Science and Information Technology, Vol. 2. Santa Rosa, CA: Informing Science Press, 335-345.

During the research, the time aspect of information and learning became emphasized. The time aspect of information was a part of that information that the designers use as a baseline in design. Moreover, the time aspect of learning was a part of the information (consisting of content in the LMS and cognitive content of the user) concerning the learner when using LMS. Thus, the design can last longer for a novice designer dealing with a great amount of information longer than for a professional designer. This is similar to a novice researcher with a vast amount of available information. With the help of experience, the designer can surmount technological, cultural and social barriers that might prevent the design of a good LMS. However, the time aspects of information, what is needed in design and used in learning, can result in redesign and relearning. In this study we reviewed what information designers' use and how it effects to their work. We focused especially on analyzing the web-survey data to see how the time aspect of learning was understood. We considered in this paper mainly the time aspect of information in the designers' work.

Based on this study, we proposed some hypothetical tools that might have an effect on filling the time gap between design and use. In this study we also found that some designers fit our classification of a designer well and others do not. However, the most significant finding was that some people change their roles during LMSD, for example from designers to content producers. As results indicated, the LMSD stakeholders' primary or secondary role was not that of "user". We might ask if they ever play the user role of LMS within actual courser, to develop better LMS. This should be researched more, because the development of open source software enables the users to construct their own LMS, where they can acquire or integrate content. Thus, we found that, presenting the possibility to design and to use information gives designers the opportunities to be users and vice versa. However, the experience about users

and professional skills for managing time-dependent information about users and tasks, counts in design work. In that design process, designers better understand what is needed by the user. We argued that information and enhancing information technology in the design of LMS is a good support to overcoming barriers, in interaction between teachers and parents, as well as between designers, content producers, teachers and students.

3.5 Article 5: "Developing a method based on semantic differential for studying LMS stakeholders' conception of learning"

Wahlstedt A. 2007. Developing a method based on semantic differential for studying LMS stakeholders' conception of learning. In M. B. Nunes & M. McPherson (Eds.) Proceedings of the International Association for Development of the Information Society E-learning conference, Vol. 2. IADIS Press, 213-217.

At the start of this research, there was a need for a method for gathering and analyzing CoL. The method should work as a research tool and as a tool enabling the understanding of peoples' CoL. Moreover, as phenomenographical research results are categories of description, there was the aim to develop a tool that could assist in achieving those results. The solution was to allow people to locate their conception by marking it as a dot somewhere within a dimension (three dimensions), whose endpoints represent opposite opinions. This article reports some results of using the method with the help of a web-survey which was used to gather those CoL. The idea for analyzing CoL by positioning data on 3D, originates from the work and ideas of Osgood et al. (1957). The article describes this method development, initiated from the first study and the focus is the designers' and content producers' CoL, because they develop the final artifacts for other stakeholders to use.

It was found that the method needed to be further developed to better understand CoL. Dimensions needed to be reconsidered and developed by studying premises of different learning theories. The dimensions scale of difference was also arbitrarily defined and lacked deeper analysis. Despite the lack of strictness, the method provided a general overview of differences between learning theories from a view based on the dimensions chosen. The method was found useful for visualization of CoL. This study also supported the LMSD by highlighting some earlier research on learning and found CoL. The experiment of using a method for mapping different CoL produced, for example, correlations of collected differentiated data. Differences between designers' and content producers' CoL were found. However results at an experimental stage could not be generalized for the whole population without further empirical research or experimental research. In addition, the personal and organizational development supporting the achievement of high goals is

further heightened by methods which engender making not only information transparent, but also conceptions about common things. A further applied method could be a predefined and organized collection of techniques and a set of rules, which would state by whom, in what order, and in what way the techniques are used to present information about conceptions. This method, applied into different contexts, could bring information about the underlying conceptions which guide people in their daily activities and goals thus enhancing interactions. This information is of value to goal-setting organizations, as the organizational goal is indirectly the personal goal of personnel (Simon 1976).

While designers and content producers in LMSD do have different CoL, the second question (Q2) was to answer whether those conceptions interact or do not interact in the development process. Based on the study, it was suggested that there should be intermediaries to foster interaction between conceptions like the mediator between subject and object in Vygotsky's (1978) basic mediational triangle. These *mediaries* could help the parties to understand other CoL. As is seen in real life situations (e.g. Vygotsky 1978), the obvious tool is communication between the stakeholders (e.g. face-to-face). However, it could be questioned whether such communication could be enhanced by using technology that would provide support by visualizing the stakeholders' CoL. It is unlikely that this would lead to a neglect of other forms of communication; instead, it would enhance communication as a whole and, further, could promote learning during LMSD. It was also proposed that a tool that would support communication in LMSD could also be included within the LMS to support discussion and thinking.

3.6 Article 6: "The advantages and challenges to support users with agent-based LMS"

Wahlstedt. A., Liu, S. & Honkaranta, A. The advantages and challenges to support users with agent-based LMS. Special issue of the International Journal for Virtual Reality. To be published.

This paper addresses the advantages and challenges of using intelligent programs, virtual instructors (VIs) for e-learning. The idea for this paper was developed in discussions with doctoral student Shenghua Liu and was also influenced by the earlier research findings, indicating another approach for LMSD. Furthermore, the issues emphasized in the earlier research results; managing time-dependent user information, designing social interactions, using different roles in LMSD and the changing CoL, required considering a different approach to LMSD. Doctor Anne Honkaranta was the third author and strengthened the article with her vast knowledge about content management issues. The article was written in an iterative process and was first

presented in an international workshop. The article submitted to the journal was elaborated together during the iterative process.

In the paper, it is proposed that a virtual instructor (VI) may act as virtual teacher within LMS. There may also be a group of collaborative agents forming a MultiAgent System to orchestrate more complex activities that a single virtual instructor may provide. The use of an agent-based LMS has advantages; teachers can save time, manage learning resources and increase interactions in teaching and supervising courses. Agent-based LMS can also help students when they are encountering problems. There are many challenges in developing learning environments with virtual instructors: the integration of virtual instructors to already operational systems (standardization, compatibility), the virtual instructor appearance, and transferring the knowledge to be taught via the virtual instructor. Further studies for clarifying the teachers' and students' needs for virtual instructors and on overcoming challenges were proposed.

3.7 Summary and discussion of the articles

Altogether, the eight articles presented the following results:

- Reasons for LMSD (A1)
- Use of roles in LMSD (A2)
- Focus should be more on a design for social interactions (A3)
- The value of the user and information about the user in LMSD (A4)
- A method for studying CoL (A5)
- An agent-based approach to LMSD (A6)

It is important to develop the learning environments for educating future generations. In LMSD, people will use roles as common identifications in their group work. However, to increase the knowledge, social interactions between different stakeholders of LMSD should be fostered. In addition, users have the most valued information when considering the system implementation. Especially with LMS, the emphasis is on learning - how the different stakeholders understand it. With methods that can highlight the commonalities and differences between CoL, better interaction and further discussion is supported. All this requires time, which is used during LMSD. One possible solution to serve the stakeholders of LMSD and to save time is to use an agent-based approach. Thus, to use one or several intelligent programs that will work as mediaries, presenting and negotiating stakeholders' issues, bridging the gap between CoL and other common issues that need to be discussed or decided. In the results section (Chapter 4) stakeholders' CoL, social interaction and time-management in LMSD, and the agent-based approach, as the main findings considered as important to focus on LMSD, are presented.

4 RESULTS AND DISCUSSION

"The products of human labor are turned into commodities when they cease to be made for the value of their use in the lives of their maker and are produced in order to exchange them, to serve the interests, and purposes of others without direct reference to the lives of their maker."
- Jean Lave (1993, 75).

In the beginning there were three research questions that needed to be answered. The first one (Q1) was "What are the stakeholders' CoL in LMSD". In chapter 4.1 this question is answered with phenomenographical result: categories of descriptions. The other two research sub-questions (Q2&3) were, "Do the stakeholders CoL interact" and "What CoL are used in LMSD". Chapter 4.2 answers to Q2, and the chapter 4.3 to Q3.

Within this research the importance was to understand how the participants consider the unified concept of learning in LMSD. This research also wanted to implicate that results can be useful for diminishing the gap between the different CoL and increasing the knowledge of how CoL may affect to the development and use of LMS. If there is a prospective way to influence the people's CoL, it might possibly affect to the factors related to e-learning. The research results are (March & Smith 1995) positive conceptions and a method for understanding how the CoL are changed from the LMSD to the use of LMS.

4.1 Conceptions of learning

The aim of this research was to present one classification of designers' and content producers' CoL. The qualitative variation with categories of descriptions was compared and found to be parallel with the earlier categories. These results are based on the assumption that humans' conceptions can be traced from their language, thus from the used utterances and words used. As earlier discussed, words carry meaning and words combinations, like sentences, have a certain meaning. Utterances, words and their meanings were studied to

get a general picture of what the respondent said learning is. It should be noticed that these utterances deal with an abstract concept (learning), which does not have a physical appearance which could be directly observed (cf. 1.4.3). Furthermore, phenomenographical results contain a set of different conceptions concerning the phenomenon under study and a researcher must not correct whether some conceptions are true or not (Isomäki 2002, 71; Järvinen 2004, 81). The analysis phase consisting of three analyses is first described before the categories of descriptions are formed.

4.1.1 Data analysis

According to the analysis among 50 respondents of a target population of an estimated 1900 people, respondents gave extensive accounts when asked about their CoL (survey questionnaire). Kraemer (1991) claims the alternative answers to a structured set of questions are made by fostering the theory that is going to be tested. For the purposes of statistic analysis, it is difficult to make the type of questionnaire where so many variations of questions could be given to the recipient. One solution is a mix of structured and nonstructured questions. The first questions in the survey were demographic and background questions (e.g. working domain, age). The main question (q1) was direct: "What is your conception of learning?" It was followed with structured questions: three 2D presentations with coordinates to position their answers (opinion) between arguments. Respondents receive instructions to place the most likely correspondence point at the coordinates, according to their CoL. After the structured questions, respondents could analyze their answer to q1 and give an extra answer (q5).

The survey answers were automatically saved as text files and then manually transferred into statistical software (SPSS 14.0). This differentiated data was analyzed by dividing the sample according to background variables such as gender and domain (both one-way ANOVA $p>0.05$). In this analysis, we focused on the designers' and content producers' assumedly different CoLs. A subgroup (n37) was extracted from the database choosing only designer and content producer role-variables. Interval and ratio scale variables were tested by using the Kolmogorov-Smirnov test. Due to the result of $p<0.05$ with all variables, we analyzed correlations with the help of crosstabs and the Pearson $\chi 2$-test. In addition, we also analyzed nominal scale relationships with the Pearson $\chi 2$-test. If two variables were not ordinal scale variables, Spearman (rs) or Kendall rank correlation coefficient was used instead of the Pearson correlation coefficient (R2). The statistical results about how respondents selected their position against three statements-pairs (matrixulation) were compared with the other analyses' results.

The answers to non-structured questions, written answers of 2-451 words long, were separately analyzed with text-analysis software for qualitative analysis (ATLAS.ti -software, cf. Muhr 1995). To have an overlook of the different aspects of the answers, they were read through. After that they were transferred into a suitable format for the program (into hermeneutic unit) and

the codes (concepts) were set up. The codes were acquired from the answers via counting the word frequencies in the answers with a simple text analysis program (Hermetic Word Frequence Counter) and selecting concepts which described the different aspects of the answers. Then the data coding made by the program was manually checked, because the program did not support fully the language used in the answers (e.g. Finnish synonyms and tenses). As for the result of the ATLAS.ti analysis, a general overview of the answers (semantic network) was established and the content of the answers was better understood. The comparison of these views of the data helped to construct the first categories of descriptions.

To establish different perspective to the data, the answers were also classified according to a list of selected learning theories. The first and fifth survey question (q1, q5) were given identification, listed in random order and then classified twice according to a list of selected learning theories. The two classifications were compared against each other in the original language (Finnish). The list of selected learning theories contained descriptions of 13 learning theories: behaviorism [B], radical behaviorism [rB], constructionism [C], radical constructionism [rC], cognitive [Cg], information processing [IP], modern IP [mIP], social constructionism [sC], humanistic and explorative learning [HE], transformative learning [Tr], collaborative learning [Co], symbolic interaction [SI] and sociocultural learning [SC]. The maximum two learning theories (none, nearest, second nearest) were selected to match each answer. Answers to survey question number one (q1) and five (q2) were differentiated into 14 different classes: answers that matched with some theories (13), and those which did not (table 6). Both researchers (R1 and R2) evaluations are considered and the answers, whose first and second matched to certain learning theories, the sum (Σq1 & Σq5) of them, and the amount of designers' (D) or content producers' (C) answers. This second analysis also verified if the answers could be classified according to the existing learning theories. For comparison, this was done twice. A different person did the classification in the second time. This gave the second categories which to compare with the first categories of descriptions. Finally the answers were read again, and keeping in mind those established categories, the categories were justified and enhanced.

TABLE 5 Answers and matching theories of learning

Evaluations		**B**	**rB**	**C**	**rC**	**Cg**	**IP**	**mIP**	**sC**	**HE**	**Tr**	**Co**	**SI**	**SC**	**-**	**Σ**
q1	R1	6	1	11	6	4	-	4	1	5	4	3	-	3	-	48
	R2	10	-	5	8	2	2	3	3	6	3	3	-	-	3	48
	Σ	13	1	12	11	6	2	7	4	9	7	5	-	3	3	83
	D	5	-	7	5	3	1	3	2	2	2	2	-	2	1	35
	C	6	1	4	4	2	-	2	-	6	1	2	-	-	1	29
q5	R1	1	2	1	1	-	1	1	7	-	6	3	-	1	-	24
	R2	2	-	2	-	-	2	-	6	1	1	5	2	-	3	24
	Σ	3	2	3	1	-	2	1	9	1	6	5	2	1	3	38
	D	-	-	-	-	-	1	-	4	1	3	3	1	-	-	13
	C	2	2	1	1	-	1	1	4	-	3	2	1	1	2	21

4.1.2 Categories of descriptions

Within two independent analyses, R1 and R2 classified the open answers reflecting the same particular theory in 50% of the cases (table 6). The correlation between the two analyzes, a choice of matching theories, increased when the supplemental answers were analyzed. R1 was more familiar with the learning theories used and used approximately 50% less time to complete the first classification than R2. However, there were three answers for which the R2 did not find a matching learning theory. The most likely implication of this is the need for a deeper understanding of the learning theories used and their nuances before trying to match them to certain expressions like sentences.

Most answers first match to some theory in the list, but less to another theory. This can be for at least two reasons. First, the list of learning theories did not include vast details of the theories, which could make it difficult for the researchers to grasp the differences between learning theories or the core idea of a certain theory. Second, answers could be difficult to evaluate using short sentences alone with one or two sentences available (Table 6). Thus the meaning of a sentence can be interpreted in multiple ways. The following categorization according to learning theories of respondents' CoL was organized:

1. No clear association to the known learning theories (answers in all lengths)
2. Can be linked to one theory (mostly answers over 500 characters)
3. More than one association to various learning theories (100-500 characters).

TABLE 6 Categories by association and length

Length of sentences (characters)	**1-100**	**100-500**	**>500**	**Σ**
No clear match (researchers disagree)	7	9	8	24
One theory matches (researchers agree)	7	6	10	23
More than one theory matches (researchers agree)	-	1	-	1

In the next analysis, keywords related to learning, which describe the main points in respondents' answers, were collected (mostly by counting word frequencies with the text-analysis software) and written down. The keywords varied from abstract words to concrete words. By employing qualitative analysis software the sentences (context) where the most frequently used words appeared within the answers were highlighted and carefully studied as well as what the respondent was saying in that sentence. At the same time it was positioned into the whole overview of the data and earlier categories. This was the most difficult part in the research, as the researcher was trying to achieve understanding about the meaning and the possible conception the respondent had. For clarification some example utterances from the answers are presented after each description of the keywords found (in italics). The form of each example is: XN(Respondent ID): …(account of conception of learning).

- According to the answers, respondents' CoL can be *broad* and *difficult* to describe or to define. It is something that *happens unconsciously*, during *life* and with the passage of *time*.

  X49: …is a multidimensional, broad and time-taking process, which can't be compressed in away that it would be possible to concern all the possible contexts.
  X32: Learning is a time-demanding, focused action.

- Concerning learning there are systems of *meaning, knowledge construction* and *structures*, and *knowledge management* described. For human learning *perception, memory, adoption, understanding, discovery, combining,* and *realization* were found to be connected in the answers.

  X43: …is a process, where meanings, understanding, skills and meta-knowledge and –skills are constructed.
  X55: Learning is discovering and combining.

- Learning can be described in different levels of abstract concepts. It is considered to be something occurring with *consciousness, activity, action, repetition, play, making* and *know-how, application, practice* and *work*. These voluntary experiences with the perspectives of c*hange, development, process and continuity* were present in answers.

  X23: …needs clear aims, schedules and practice.
  X61: …is not just increasing knowledge; it is also continuous change and development of thinking.

- *Motivation, needs, benefits, aims* and *novelty* are all issues that were seen as being closely related to preceding and advancing learning. Just as *emotions, appraisal, tendency, direction*, and the *ability* to learn are supervising and guiding learning. *Interaction, sociality, community, context* and *culture* are an important source of *change* and are around in human learning. It is not meaningful to categorize or describe all these abstract concepts in here, but what is more important is to notice the amount of emphasis and instances that we found regarding *novelty*, *community*, *benefits* and *interaction* in the answers.

  X15: …is a continuous process and always present in life, like eating and sleeping…if one stops dreaming, one stops growing (citing Kuhn)...and other way around…by learning one can see differently, understand things from a new perspective and wants to perhaps act differently…learning starts from some kind of anomaly (citing Kuhn)…which will lead to some level of change in paradigms at the best…emotional intelligence is important in learning…experience is what generates learning.

The findings were summarized into the following categorization (UNCOVER), which represent how the respondents expressed what they think the learning is:

1. Universal concept
2. Continuous cognitive change and development process
3. Voluntary action
4. Experience
5. Real and meaningful (social) interaction with the environment

The answers in relation to the selected learning theories and the meaningful content of the answers were evaluated against central ideas from the literature (Appendix I). UNCOVER-categories number 2-4 share resemblances with Marton et al.'s (1993) categorization that learning means increasing one's knowledge, memorizing and reproducing, applying, understanding, seeing something in a different way and changing as a person. Among those first three, learning is seen as primarily reproducing and within the last three as primarily seeking meaning. The difference is that in the UNCOVER category the voluntary action is emphasized instead of the application of knowledge. In addition, learning as a universal concept is also classified by Illeris (2002). In that sense the UNCOVER-categorization only emphasises conceptions which are already known. However, these LMS designers' and content producers' CoL have not been researched earlier and the time relation is emphasized here.

According to the content and word frequencies of the answers, respondents' CoL was generalized to include five main approaches. From the differential data was found that 1) designers and females consider learning to be a slightly more internal creation and the adding of information, where as 2) content producers and males consider learning to be slightly more an act of receiving and adapting information from the environment. Also 3) CoL relate strongly to time and can be analyzed at least three-dimensionally. These findings suggest that (social) interaction with the environment is variable which counts in learning (result from article 4) and different time aspects of learning should be understood and researched (result from article 5). Next, these other findings are shortly discussed and in 4.4, as one solution to these challenges in LMSD, an approach of integrating agent technology with educational technology is presented. Thus, by using software agents, social interactions and time-management issues in learning can be enhanced.

4.2 Social interactions

"..there is not in the world a better nation. They love their neighbors as themselves, and their discourse is ever sweet and gentle, and accompanied by a smile; and though it is true that they are naked, yet their manners are decorous and praiseworthy."
- Cristopher Columbus (Dee Brown 2001).

The interaction happens between those who have a relationship, meaning here a situation in time, to transfer some information. For example, in the medical care, interaction happens between a doctor and a patient, when the patient requires something from the doctor and the doctor gives healthcare guidance. The meaning of the interaction is to transfer information, to foster understanding and to improve the situation. The doctor helps the patient to understand what is needed to improve the patient's situation. This interaction consists of verbal and nonverbal communication. The orientation, expressions, gestures and positions are important parts of this interaction. Indeed, one central issue in interaction is the ability to tune into the way the other communicates, for example to find "the right channels or frequency" which the other uses. The ability to discuss with people of different ages, with different backgrounds or from different cultures is essential for any professional engaged within various social interactions. And as described earlier, in social interaction, social is marked by friendly companionship with others, seeking and enjoying the company of others. In the doctor-patient relationship a good social interaction would be towards increasing the sense of well-being: The patient rejoices at recovering and the doctor rejoices at helping the patient.

In e-learning, interaction happens mostly between student and teacher, between students or student and learning content. For example, according to LOM (Hodgins et al. 2002), the learning objects educational metadata group contains properties such as interaction type, amount of interaction and target group. Type of interaction means the interaction between the content and the student, and it can have values of presentation (one can read, see or listen to it), be active (one can have feedback, e.g. a test), a combination, and undefined. In e-learning the interaction requires skills of using the technical tool provided to support learning, and to tune into the way the other participant is communicating. When speaking of interaction between the learning content and student, more intelligent content is required. For example pedagogical agents as intelligent learning objects (Silveira et al. 2004).

The requirement of social interaction skills increases the future LMSD and content efforts. Social interaction increases the transfer of thoughts and ideas, as well as increasing the transformation of conceptions. The description of conceptions needs continuous evaluation and representation, increasing the information transfer between LMSD stakeholders. Increasing social interaction between different stakeholders is essential to decrease the misconceptions. If we mean by a learning society a friendly association and learning with others, the design of social interactions via LMS should be one development goal.

4.3 Time

Time is of much concern in almost all systems engineering and re-engineering efforts for example LMSD interactions takes time. Time-based competition is therefore a potential source of competitive advantage (Sage 1995, 525). Thus, time should be strategically managed and put aside for the situations which are considered important and require more time than others. For example, Stalk and Hout (1990) indicate several tasks to bring about time-based competition as a critical parameter for strategic management in organizations. Those task include: 1) faster and more flexible value-delivery systems than that of competitors, 2) identifying the customers value basis and responsiveness issues, and then focus on customers with the greatest sensitivity to value and responsiveness, 3) staying close to those customers so they become dependent on the organization, 4) identifying and implementing strategies that "surprise" competitors. Although there would be better systems, if more time would be reserved for the design, to reserve time, it should be first strategically managed.

From another perspective, the designing of an IS is a moral problem because it makes one party, the system designer, impose an order on another. Failures happen, because designers cannot design large systems, which would support individual user actions so that the system would operate from a unique human perspective. Thus, there is not enough information about the individuals' needs, goals, skills and situations at a certain moment of time. The CoL in the time frame of LMSD may or may not match the CoL in the time frame of LMS use. Moreover, if that information could be gathered, there would not be time to do so and neither would there be time to analyze and act according to it. Perhaps, if time would not be considered as a limitation of human actions, the information needed (body of knowledge) could be shrunk into models and presented at the levels of details, thus clarifying each others.

Currently people have less time. The pace of work is not decided by the people who do it. It is recommended that although it is not the people's own fault, they should be wise and neutralize the situation. Sometimes they might need to start from the start from the beginning or at least should be given that opportunity. The lack of time in the design and development results systems which are used with only those skills the person has in that certain situation. Sometimes users do not have the adequate skills to use the emerging systems. In addition, only systems which satisfy the needs and goals of a human being and society should only be used. This also means that systems are designed to be extinguished or wasted. However, as Simon notes (1976) human needs cannot be satisfied with human resources. Meyer (1993, 526-527) has described four basic principles that support the fast cycle-time strategy: 1) paying customers, 2) continuous improvements 3) interdependent systems managed by using cycle-time measures, and 4) quick learning and rapid change abilities for competitive advantage. That change can be initiated at any organizational re-engineering level and those principles can be considered also in LMSD.

4.4 An agent-based approach to LMSD

"For a long time to come, man, even in association with his most powerful computing devices, will be navigating a very small ship in a vast sea of alternatives and their possible consequences."
- Herbert A. Simon (1978, 504)

From the definition for system development and the perspective of LMSD, the learning was identified as a core part of the change process in the system development. From this research perspective, in order to design successful systems, the change process (including learning) is the most fundamental process to understand and to manage. When we speak about the process of change, we need to consider the time aspect of information as the information is dynamically changing.

In respect to earlier definitions of ISD (e.g. Welke 1983; Lyytinen 1987a), in Figure 2 is presented the shift of the emphasis from objective systems (OS), development group (DG) and objectives (O) to the change process within the environment, circled by the time. It is proposed that this ISD approach better inhabits the stakeholders' different CoL and the change process happening in the time-bounded environment.

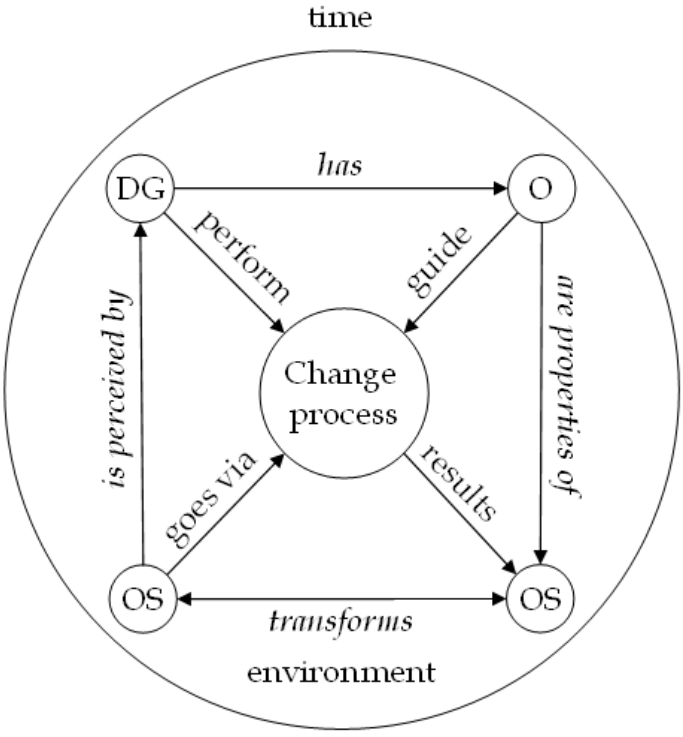

FIGURE 2 The change process as the core in the system development.

On the basis of this approach and using intelligent agents supporting human tasks (e.g. McBurney & Luck 2007) the following model (Figure 3) for an agent-based LMS was proposed for handling the complexity of learning management. The communications between different resources are orchestrated by an unlimited amount of agents cooperating and negotiating to support users to achieve certain learning goals. The amount of agents is not critical as each agent can have its own beliefs, desires and intentions (e.g. Kant & Thiriot 2006) and they can be programmed to do multiple tasks. Thus, LMS interacting with the student is a community of agents (Griss et al. 2002) which carry out different kinds of tasks such as resources allocation. For example, in Figure 3, a data agent transacts (makes queries and crawls databases) with different external data sources like learning object repositories and with other agent systems, to gather needed information.

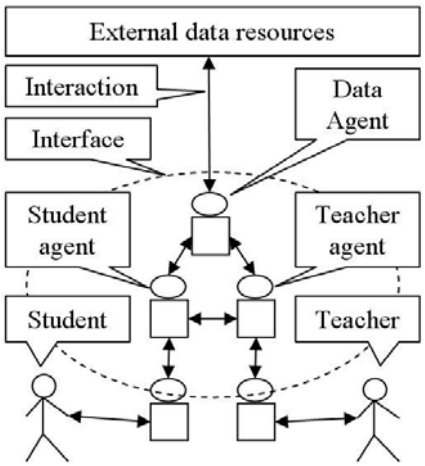

FIGURE 3 Model of agent-based LMS

The whole nature of the agent-based LMS is that it works as a mediaries. It is a virtual instructor (VI, Doswell 2006), a learning companion (Johnson et al. 2000) for the users (student agent) which will pop up when the user indicates a need for help. It can work, as a time manager (teacher agent) for the teachers, by orchestrating meeting arrangements and classroom reservations. Interaction between virtual instructor and users can be initiated upon request, indirectly by the system monitoring the users' performance and automatically detecting when the assistance is needed as well as by a combination of these activities. This community of agents is a learning community, able to learn the user behavior, users' actions streaks and ways of decision-making. However, the amount of knowledge that the user elaborates via the system is clearly dependent on user interaction with the system. With the information gathered via several agents (e.g. transactions between agents), agent-based LMS work towards a general model of the typical user and user's CoL. These CoL are communicated back and forth between the users via multimodal interface.

4.5 Discussion

The large systems of sciences are as useful as their descriptions of the reality and predictions of phenomenon; especially as phenomenon happens at a certain time. Despite the descriptive analysis and theories of certain phenomenon in a certain context, we still cannot describe and predict uncertainties involved in phenomenon happening at a special moment. The tradition, the language and our ability to interpret and gain meaning in the world are continuously specific to a concrete moment in time (Boland 1987, 371).

We used a sampling method to gather quantitative data (CoL). However, sampling methods based on consideration are subjective. The results are more like specimens. The lack of a pinpoint method for choosing sample units can lead to misleading results, because the method does not ensure a representative sample. Something is left out of the sample. Indeed, it is recommended that one uses convenience sampling to test (Yin 1994, 7), for example, a survey form, to gain preliminary results and develop ideas. A web-based survey was used to collect data from two approaches (predefined, structured and non-structured, open questions), and a well-known statistical program was used for the data analysis. As survey research involves gathering information for scientific purposes from a sample of a population using standardized instruments or protocols, our web-based survey was more a data collection technique than a sound survey research. Moreover, when using a survey the observable units are not controlled. Lastly, our response rate was 48%, while a response rate of 75-90% is widely held as sufficient to support generalization from a surveyed sample of the population (Gall et al. 1996). For comparison, Burkell (2003) denotes that from 1996 through 2001 in three major library and information science literature journals have an average response rate of 63%.

According to our analysis, respondents gave extensive accounts of CoL, but partly because the answers were of different lengths, the association to the learning theories was not always clear or possible. As earlier said, despite the misinterpretations, it is important to try to understand the CoL. If it is possible to increase knowledge of learning by studying CoL, then these results will probably help people to understand more what and why something is needed for better LMS. However, the level of understanding depends on the amount of time used in studying them and the context (culture, organization, place and people) where they are studied. As respondents' answers gave us an extensive CoL, results cannot be generalized for the whole population without further empirical research or experimental research.

If it is possible to increase the knowledge of learning by studying CoL of those people who are within the development process, then this research's results will probably help people to understand more what is needed to enhance LMS and LMSD. Moreover, the applied method for understanding different conceptions of any concept in the development of any artifact is a

predefined and organized collection of techniques and a set of rules. These rules state by whom, in what order, and in what way the techniques are used.

The proposed model of Agent-based LMS is far from complete. As Curtis et al. (1992) define that a model is an abstract representation of reality that excludes much of the world's infinite detail. The purpose of a model is to reduce the complexity of understanding or interacting with a phenomenon by eliminating the detail that does not influence its relevant behavior. Therefore, a model reveals what its creator believes is important in understanding or predicting the phenomena modeled.

5 CONCLUSIONS

Unique conceptions about everyday things are involved in our life. To design, implement and use systems around us, we should try to understand the different conceptions related. Indeed we referred to conception as conceiving and understanding something. Although the conceptions are considered to be revealed by the subject's expressions with which they describe their perceptions, experiences and inner concepts, these expressions cannot contain the whole dynamic conceptions of being human. However we emphasize that it is important to at least try to understand these conceptions, because they are intentional in that they guide people in their daily activities and allow for the world to be perceived as meaningful to them. If we want to develop a meaningful and useful artifact, we should try to understand underlying conceptions related to artifacts. It is noteworthy that the activity of development was understood as an intellectual and personal process, to create and develop a certain artifact for a reason. It is a process which takes its form and consequences according to the conceptions of the performers and things related to the subject of the process (Isomäki 2002, Mathiassen 1998).

The research results were revised CoL categories, a method for understanding CoL and an evaluation of the LMSD issues. As a conclusion, on the basis of the results, there are many reasons for LMSD. In LMSD, stakeholders need roles for task identification and to increase their knowledge through cooperation. There should be more focus on design and use of social interaction in LMSD. There is an inherent value in the experience of users and the time-dependent user information management in LMSD. The results from earlier research on learning theories and the test of a preliminary method for studying stakeholders' CoL, gives an updated overview of their CoL. And finally, an agent-based approach to LMSD is one solution to answering these presented LMSD challenges that have been presented.

These results help people understand the reasons for LMSD. The practical result will be the integration of the issues found into the LMSD. The developed method can work as a tool for better understanding the stakeholders' conceptions of different concepts in an artifact development. By applying the

method into different contexts, one can bring information about the underlying guiding conceptions and improve the interaction. This is of value to the goal-setting organizations, as the organizational goal is indirectly the personal goal of the personnel. Beside earlier system development models, the learning was identified in system development as the core part of the change process. For successful systems, that change process is the most fundamental process to understand and to manage, and one also needs to consider the time aspect of dynamically changing information. Additionally, the personal meaning which students construct in any learning experience includes not only the information and the context, but the purpose, as understood by the student. Which means that any learning for which students do not see a real purpose outside classrooms and exams will be stored (if it is stored) in ways which inextricably link it to that set of contexts (Crebbin 2000). In this direction, there may be a need for virtual supervisors or supporting systems for learners to understand and manage their learning in emerging virtual realities.

As Checkland & Holwell (1998, 217) note that 'information' is frequently taken to mark a revolution as important as the Industrial Revolution of the late 18th and early 19th century, which focused on 'energy'. Concepts like 'learning', 'ubiquitous', 'pervasive' and 'climate change' emerged in the 20th century. Perhaps the concepts are constantly changing, from important to unimportant and vice versa, according to the changes in the human environment, targets of concentration and use of interactions.

APOLOGY

"...keep on hearing, but do not understand; keep on seeing, but do not…"
-Isaiah 6:9 (Anon, 2001)

Lastly, the reality is more than a conceivable concept, as language, mathematics, religion and learning can be. From that perspective, reality consists of the general and specific, the whole and the parts, thus further giving space for contradictions and for arguments and counterarguments. Yet, the counterarguments are not against each other, rather they fulfill each others. As dark and light are defined as reciprocal and easy to describe in contrast to one another, combining these two is more than the sum of them.

YHTEENVETO (FINNISH SUMMARY)

Osallistujien käsitykset oppimisesta oppimisympäristöjen kehittämisessä

Oppimisympäristöt ovat voimakkaasti mukana opetuksessa ja koulutuksessa. Esimerkiksi kouluopetuksessa oppimisympäristöjä käytetään tukemaan lasten ja nuorten elinikäistä oppimista. Tässä tutkimuksessa oppimisympäristöiksi katsotaan ne elektroniset verkkopohjaiset tietojärjestelmät, joilla tuetaan oppimista ja opetusta. Juuri laajan kohdealueensa vuoksi oppimisympäristöjen kehittäminen on moniulotteinen ja laaja prosessi, jonka osallistujia ovat erilaisia rooleja käyttävät ihmiset. Roolit ovat tärkeitä, koska niiden avulla tunnistetaan tietyn asian tai kokonaisuuden osaajat. Esimerkiksi kehittämisprosessissa voi olla mukana suunnittelijoita, sisällöntuottajia, opettajia ja oppilaita.

Oppimisympäristön kehittämisessä laaditaan usein vaatimusmäärittely, jolla pyritään kuvaamaan oppimiseen ja opetukseen tarkoitetun tietojärjestelmän käyttäjien tarpeet. Käyttäjien tarpeiden kuvaaminen on tärkeää ja siihen tarvitaan monia menetelmiä, mutta lisäksi olisi hyvä ymmärtää myös tarpeiden taustalla olevia syitä, jotta voitaisiin perustellusti löytää tarpeita tyydyttäviä tietoteknisiä ratkaisuja. Järjestelmän kehittämisessä ei voida ottaa kaikkia asioita huomioon koska haasteeksi nousee käytettävissä oleva aika. Vaikka aikaa tarvitaan niin järjestelmänkehittämisessä kuin yleisesti ihmisten välisessä vuorovaikutuksessa, on yleensä aikaa käytettävissä rajoitettu määrä. On siis kuvattava harkitusti käyttäjän keskeiset tarpeet ja syyt niiden taustalla. Vaikka tarjolla on paljon oppimista tukevia järjestelmiä, on haasteellista kehittää järjestelmä tukemaan erityisesti yksilöllistä oppimista. Järjestelmän tulisi tukea opittavan informaation esittämistä, siirtämistä, opettamista, jakamista ja jäsentämistä, mukautuen käytönaikaisten tarpeiden muutoksiin. Koska oppimiskäsitykset muiden käsitysten ohella ohjaavat osallistujien toimintaa, tutkimuksessa jäsennettiin oppimisympäristöjen kehittämiseen osallistuvien käsityksiä oppimisesta. Vaikka tehdyssä tapaus- ja kysely tutkimuksessa havaittiin näiden käsitysten oppimisesta sisältävän samankaltaisuuksia keskenään ja liittyvän tunnettuihin oppimisteorioihin, jokainen käsitys oli ainutlaatuinen ja käsitysten tavoin ajassa muuttuva. Keskeistä oppimiskäsityksissä on siis niiden muuttuminen. Koska ihmisen käsitykset muuttuvat ja ihminen toimii muuttuvassa ympäristössä, myös tietojärjestelmät, erityisesti oppimista tukevat tietojärjestelmät, tulisi kehittää jatkuvan muutoksen pohjalta. Tärkeää järjestelmän valinnan lisäksi on siis se millaisia käsityksiä valittavan järjestelmän kehittämisen taustalla on.

REFERENCES

Anderson, B. F. 2002. The three secrets of wise decision making. Portland Or, USA: Single Reef Press.

Anderson, R. 1998. Imagery and spatial representation. In W. Bechtel & G. Graham (Eds.) A Companion to Cognitive Science. Malden, MA, USA: Blackwell Publishers, 204-211.

Anon. 2001. The Holy Bible. [online] English standard.version Good News Publ. Available: http://www.gnpcb.org/esv/ [July 17, 2004]

Argyle, M. 1987. The psychology of happiness. USA: Taylor & Francis.

Argyle, M. & Dean, J. 1965. Eye-contact, distance and affiliation. Sociometry, 28 (3), 289-304.

Avison, D. E. & Fitzgerald, G. 1995. Information systems development: methodologies, technologies, tools. (2nd edition), London: McGraw-Hill.

Baddeley, A. D. 2000. The episodic buffer: A new component of working memory? Trends in Cognitive Sciences 4 (11), 417-423.

Barnes, J. (Ed.) 1984. The works of Aristotle. Princeton: Princeton University Press. 2 vols.

Bateson, G. 2000. Steps to an ecology of mind. Chicago: University of Chicago Press.

Bentall, R. P. 1992. A proposal to classify happiness as a psychiatric disorder. Journal of Medical Ethics 18 (2), 94-98.

Bernard, C. 1957. An introduction to the study of experimental medicine. Republication of the first English translation. England: Dover Publications.

Billman, D. 1998. Representations. In W. Bechtel & G. Graham (Eds.), A Companion to Cognitive Science. Malden, MA USA: Blackwell Publishers, 649-659.

Blokdijk, A. & Blokdijk, P. 1987. Planning and design of information systems. London: Academic Press.

Boland, R. J: Jr. 1987. The in-formation of information systems. In R. J. Jr. Boland & R. A. Hirschheim (Eds.), Critical issues in information systems research. New York, NY: John Wiley & Sons, 363-379.

Boland, R. J. Jr. & Hirschheim, R. A. (Eds.) 1987. Critical issues in information systems research. New York, NY: John Wiley & Sons.

Bostrom, R. P. & Heinen, J. S. 1977. MIS Problems and Failures: A Socio-Technical Perspective. Part I: The causes, MIS Quarterly 1 (3), 17-32.

Bradburn, N. M. & Sudman, S. 1988. Polls & surveys. San Francisco: Jossey-Bass.

Bransford, J., Brown, A. & Cocking, R. (Eds.) 1999. How people learn. Washington, DC: National Academy Press.

Brown, D. 2001. Bury my heart at Wounded Knee – An Indian history of he American west. NY: Henry Holt & Company.

Bruner, J.S. 1966. Toward a theory of instruction. Cambridge, MA: Harvard University Press.

Burkell, J. A. 2003. The dilemma of survey nonresponse. Library and Information Science Research 25 (3), 239-263.

Burrell G. & Morgan G. 1979. Sociological paradigms and organizational analysis. London: Heinemann.

Bush, V. 1945. As we may think. The Atlantic Monthly 176 (1), 101-108.

Cannon, W. B. 2007. The wisdom of the body [online] (Orig.1932). NY: W.W. Norton. Available: http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=3117174 [December 9, 2005]

Capurro, R. & Hjørland, B. 2003. The concept of information. In B. Cronin (Ed.) Annual Review of Information Science and Technology 37 (1), 343-411. Available: http://www.capurro.de/infoconcept.html [August 20, 2006]

Catenazzi N. & Sommaruga, L. 2002. Re-using contents a recipe for e-learning. Paper presented at the ICNEE 2002 Conference, May 8-11, Lugano, Switzerland.

Checkland, P. & Holwell, S. 1998. Information, systems and information systems. Chichester: John Wiley & Sons.

Ciborra, C. (1987). Management information systems: a contractual view. In R. Galliers (Ed.) Information analysis: Selected readings. Sydney: Addison-Wesley, 125-137.

Cliff, A. F. 1998. Teacher-learners' conception of learning: Evidence of a "communalist" conception amongst postgraduate learners? Higher Education 35 (2), 205-220.

Collins, B. A. 2001. Web-based rapid prototyping as a strategy for training university faculty to teach web-based courses. In B. Khan (Ed.) Web-Based Training. Englewood Cliffs, NJ: Educational Technology Publications, 459-469.

Contu, A., Grey, C. & Örtenblad, A. 2003. Against learning. Human Relations 56 (8), 931-952.

Crebbin, W. 2000. Revisioning learning - contributions of postmodernism, constructivism and neurological research. [online] In P. L. Jeffery (Ed.) AARE 2000 Conference Papers, Sydney: AARE, Available: http://www.aare.edu.au/00pap/cre00462.htm [August 15, 2007]

Cunningham, J. B. 1997. Case study principles for different types of cases. Quality and Quantity 31 (4), 401-423.

Curtis, B., Kellner, M. I. & Over, J. 1992. Process modeling. Communications of the ACM 35 (9), 75-90.

Davidson, R.J. & Irwin, W. 1999. The functional neuroanatomy of emotion and affective style. Trends in Cognitive Science, 3 (1), 11-21.

Doswell, J. T. 2004. Pedagogical embodied conversational agent. In Kinshuk, C.-K. Loo, E. Sutinen, D. G. Sampson, I. Aedo, L. Uden & Kähkönen, E. (Eds.) Proceedings of the IEEE International Conference on Advanced Learning Technologies (ICALT'04). Los Alamitos, CA: IEEE Computer Society, 774-776.

Doswell, J. T. 2006. Instruction through the ages: Building pervasive virtual instructors for life long learning. In Kinshuk, R. Koper, P. Kommers, P. Kirschner, D. G. Sampson & W. Didderen (Eds.) Proceedings of the IEEE

International Conference on Advanced Learning Technologies (ICALT'06). Los Alamitos, CA: IEEE Computer Society, 1119-1120.

Downes, S. October 18, 2007. How the net works. CEGSA RAMpage Magazine Available: http://www.downes.ca/cgi-bin/page.cgi?post=42068 [November 19, 2007]

Edelson, P. J. & Pittman, V. V. 2001. E-Learning in the United States: New directions and opportunities for university continuing education. Indian Journal of Open Learning 10 (2), 123-34.

EduTools. 2007. [online] CMS: Product List. Available: http://www.edutools.info [December 28, 2006].

Ehrlich, J., Zerrouki, A., Galisson, A. & Demassieux, N. 1996. Generic model for smart-sensor based data acquisition system. In K. A. Murphy & D. R. Huston, D.R. (Eds), Smart Structures and Materials 1996: Smart. Sensing, Processing and Instrumentation, Proceedings of SPIE 2718, San Diego, CA, USA, February 26, 279-290.

Eisenhardt, K. M. 1989. Building theories from case study research. Academy of Management Review 14 (4), 532-550.

Ekman, P. 1993. Facial expression and emotion. American Psychologist 48 (4), 384-392.

Ekman, P., Davidson, R. J., Ricard, M. & Wallace, B. A. 2005. Buddhist and psychological perspectives on emotions and well-being. Current Directions in Psychological Science 14 (2), 59-63.

El Emam, K., Drouin, J.-N. & Melo, W. 1998. SPICE - the theory and practice of software process improvement and capability determination. USA: Edwards Brothers.

Engeström, Y. 1987. Learning by expanding: An activity-theoretical approach to developmental research. Helsinki, Finland: Orienta-Konsultit Oy.

Eteläpelto, A. 1998. The development of expertise in information systems design. Jyväskylä: Jyväskylä University Printing House.

Eysenck, M. & Keane, M. 2000. Cognitive psychology. A student's handbook (4th ed.) NY: Psychology Press.

Faulkner, C. 1998. The essence of human-computer interaction. Upper Saddle River, NJ: Prentice Hall.

Fink, A. & Kosecoff, J. 1985. How to conduct surveys. Beverly Hills: Sage.

Fogel, A., Nwokah, E., Dedo, J. Y., Messinger, D., Dickson, K. L., Matusov, E., & Holt, S. A. 1992. Social process theory of emotion: A dynamic systems approach. Social Development 1 (2), 122-142.

Fowler, F., J. 1988. Survey research methods. Newbury park: Sage.

Frank, R. H. 2004. How not to buy happiness. Dædalus 133 (2), 69-79.

Gagné, R. M. 1965. The conditions of learning, NY: Holt, Rinehart and Winston.

Gall, M. D., Borg, W.R. & Gall, J.P. 1996. Educational research: An introduction. White Plains, NY, USA: Longman Publishers.

Galliers, R. D. 1991. Choosing appropriate information systems research approaches: A revised taxonomy. In H. E. Nissen, H. K. Klein & R. Hirschheim (Eds.) Information Systems Research: Contemporary

Approaches and Emergent Traditions, Proceedings of IFIP TC8/WG 8.2 Conference. Amsterdam, North-Holland: Elsevier Science Publishers

Gazzaniga, M. S., Ivry, R. B. and Mangun, G. R. 2002. Cognitive neuroscience. The biology of mind (2nd ed.) NY: WW Norton & Company.

Gemmell, J., Lueder, R. & Bell, G. 2003. Living with a lifetime store. ATR Workshop on Ubiquitous Experience Media, Sept. 9-10, 2003, Keihanna Science City, Kyoto, Japan.

Goel, V. & Pirolli, P. 1992. The structure of design problem spaces. Cognitive Science 16 (3), 395-429

Goldstein, E. B. 1999. Sensation and perception. (5th ed.) Pacific Grove, CA: Brooks.

Griss, M., Letsinger, R., Cowan, D., VanHilst, M. & Kessler, R. 2002. CoolAgent: Intelligent digital assistants for mobile professionals. HP Laboratories Palo Alto Report.

Gurwitsch, A. 1964. The field of consciousness. Pittsburgh: Duquesne University Press.

Gurwitsch, A. 1970. Towards a theory of intentionality philosophy and phenomenological research 30 (3), 354-367.

Hakkarainen, K., Lipponen, L. & Lonka, K. 1999. Tutkiva oppiminen – älykkään toiminnan rajat ja niiden ylittäminen. Porvoo: WSOY.

Hannafin, M. J. 1993. Emerging technologies, ISD, and learning environments: Critical perspectives. Educational Technology Research and Development, 40(1), 49-63.

Harper, D. 2001. Online etymological dictionary. [online] Available: http://www.etymonline.com/index.php [August 20, 2007]

Hativa, N. 1994. What you design is not what you get: Cognitive, affective, and social impact of learning with ILS - An integration of findings from six-years of qualitative and quantitative studies. International Journal of Educational Research 21 (1), 81-112.

Hebb, D. O. 1949. The organization of behavior: A neuropsychological theory. NY: Wiley-Interscience.

Hirschheim, R. A., Klein, H. K. & Lyytinen, K. 1995. Information systems development and data modeling. Cambridge: Cambridge University Press.

Hodgins, W. et al. July 15, 2002. Draft standard for LOM. [online]. Available: http://ltsc.ieee.org/doc/wg12/LOM_1484_12_1_v1_Final_Draft.pdf [January 31, 2007]

Horton, W. & Horton, K. 2003. E-learning tools & technologies. Indianapolis, Indiana: Wiley.

Huang, A. 1998. The complete I-Ching. Rochester, Vermont: Inner Traditions International.

Hubka, V. & Eder W. E. 1987. A scientific approach to engineering design. Design Studies, 8 (3): 123-137

Humbrey, W. S. & Feiler, P. H. 1992. Software process development and enactment: Concepts and definitions. Software Engineering Institute Technical Report Series 92. Pittsburg: Carnegie Mellon University.

Häkkinen, P. 1996. Design, take into use and effects of computer-based learning environments – designer's, teacher's and student's interpretation. Publications in Education 34. Joensuu: University of Joensuu. Academic dissertation.

Häkkinen, P. 2002. Challenges for design of computer-based learning environments. British Journal of Educational Technology, 33 (4), 461-469.

Isomäki, H. 2002. The prevailing conceptions of the human being in information systems design: systems designers' reflections. Tampere: Department of Computer and Information Sciences, University of Tampere.

Isomäki, H. & Häkkinen, P. 2001. Information systems professionals' conceptions of learning. In H-K. Isomäki, J. Kari, M. Marttunen, A. Pirhonen & J. Suomala (Eds.) Human centered technology and learning. Jyväskylä, Finland: Department of Teacher Education, University of Jyväskylä, 157-188.

Jenkins, M. A. & Johnson R.D. 1977. What the information analyst should know about body language. MIS Quarterly 1 (3), Sep., 33-47

Johnson, J. & Henderson, D. A. 2002. Conceptual models: begin by designing what to design. ACM Interactions, 9 (1), 25-32.

Johnson, W. L., Rickel, J. W. & Lester, J. C. 2000. Animated pedagogical agents: face-to-face interaction in inter-active learning environments. International Journal of Artificial Intelligence in Education 11 (1), 47-78.

Jois, K. P. 2002. Yoga mala. Finnish translation by Juha Javanainen, 2002. Stampa Lito Covi, Rome, Italy: Sri K. Pattabhi Jois Ashtanga Yoga Community. (Orig. 1962).

Jonassen, D.H. 1993. Thinking technology. Educational Technology, 34 (4), 35–37.

Joshi, K. D. & Sarker, S. 2003. A framework to study knowledge transfer during information systems development (ISD) process. In E. Coakes (Ed.) Knowledge management: current issues and challenges. Hershey, PA, USA: IGI Publ., 25-37.

Joyce, B. & Weill, M. 1986. Models of teaching. New Jersey: Prentice-Hall.

Järvinen, P. 2004 On research methods. Tampere: Juvenes-Print.

Kaipala, J. 2000. Integrating metaCASE environments by using hypertext. Computer science and information systems reports 25. Jyväskylä: University of Jyväskylä.

Kahneman, D., Krueger A. B., Schkade D. A., Schwarz, N. & Stone, A. A. 2004. A survey method for characterizing daily life experience: the day reconstruction method. Science 306 (5702), 1776-80.

Kant, J.-D. & Thiriot, S. 2006. Modeling one human decision maker with a multi-agent system: The CODAGE approach. In P. Stone & G. Weiss (Eds.) Proceedings of the AAMAS'06, New York, NY, USA: ACM Press, 50-57.

Kearins, J. 1981. Visual spatial memory in Australian Aboriginal children of desert Regions. Cognitive Psychology 13 (3), 436-460.

Khan, B. H. 2001. A framework for web-based learning. In B. H. Khan (Ed.), Web Based Training. Englewood Cliffs, NJ: Educational Technology Publications.

Khan, B. H. 2004. People, process and product continuum in e-learning: The e-learning P3 model. Educational Technology 44 (5), 33-40.

Kilpinen, K. 2004. Reflective teacher using the computer-network in teaching; how the psycho-epistemological learning styles help to better design learning environments. Tampere: University of Tampere. Academic dissertation.

Kimble, G. A. 1961. Hilgard and Marquis' conditioning and learning (2nd ed.) NY: Appleton-Century-Crofts.

King, L. A. & Napa, C. K. 1998. What makes a life good? Journal of Personality and Social Psychology 75 (1), 156-165.

Klein, H. K. 1984. Which epistomologies for future information systems research. In M. Sääksjärvi (Ed.) Proceedings of the 7th Scandinavian Research Seminar on Systemeering (part I). Helsinki: Helsinki School of Economics, 60-90.

Kling, R. & Scacchi, W. 1982. The web of computing: Computer technology as social organization. Advances in Computers 21 (1), 2-90.

Konorski, J. 1967. Integrative activity of the brain: An interdisciplinary approach. Chigago, USA: University of Chicago Press.

Koskinen, M. & Pirinen, A. 2007. Boundary actors in user-developer communication. In T. Tiainen, H. Isomäki, M. Korpela, A. Mursu, P. Nykänen, M.-K. Paakki & S. Pekkola (Eds.) Proceedings of the 30th Information Systems Research Seminar in Scandinavia (IRIS). Tampere, Finland: Department of Computer Science, Tampere University press, 950-967.

Kraemer, K. L. 1991. Introduction. In Kraemer (Ed.), The information systems research challenge: Survey research methods, Vol. 3. Boston: Harvard Business School, xiii-xviii.

Land, F. 1985. Is an information theory enough? The Computer Journal 28 (3), 211-215.

Landauer, T. K. 1986. How much do people remember? Some estimates on the quantity of learned information in long-term memory. Cognitive Science, 10 (4), 477-493

Langley, P. & Simon, H. A. (1981). The central role of learning in cognition. In J. R. Anderson (Ed.), Cognitive skills and their acquisition. Hillsdale, NJ: Lawrence Erlbaum.

Lave, J. 1988. Cognition in practice: mind, mathematics, and culture in everyday life. Cambridge: Cambridge University Press.

Lave, J. 1993. Situating learning in communities of practice. In L.B. Resnick, J. M. Levine, & S. D. Teasley (Eds.) Perspectives on socially shared cognition. Washington, DC: APA, 17-36.

Lave, J. & Wenger, E. 1991. Situated learning legitimate peripheral participation. Cambridge: Cambridge University Press.

Lehtinen, E., Kinnunen, R., Vauras, M., Salonen, P., Olkinuora, E. & Poskiparta, E. 1989. Oppimiskäsitys, (Conception of learning) (in finnish). Helsinki, Finland: Edita.

Loftin, J. D. 1994. Religion and Hopi life in the twentieth century Indiana. Indiana University Press.

Lucas, H. C. Jr. 1975. Why information systems fail. NY: Columbia University Press.

Lyman, P. & Varian, H. R. 2000. How much information? The Journal of Electronic Publishing, 6 (2), 2000. Available: http://www.press.umich.edu/jep/06-02/lyman.html [May 24, 2005]

Lyytinen, K. 1987a. A taxonomic perspective of information systems development: Theoretical constructs and recommendations. In R. J. J. Boland & R. A. Hirschheim (Eds.) Critical Issues in Information Systems Research. New York: John Wiley & Sons, 3-41.

Lyytinen, K. 1987b. Different perspectives on information systems: problems and solutions. ACM Computing Surveys, 19 (1), 5-46.

Lyytinen, K. & Hirschheim, R. 1988. Information systems failures—a survey and classification of the empirical literature. In Oxford Surveys in Information Technology. NY: Oxford University Press, 257-309.

March, S. T. & Smith, G. F. 1995. Design and natural science research on information technology. Decision Support Systems 15 (4), 251-266.

Marsh, C. 1982. The survey method. London: George Allen & Unwin.

Marshall, S. J. 2001. The mandate of heaven: hidden history in the I Ching. NY: Columbia University Press.

Marton, F. 1975. On non-verbatim learning 1. Level of processing and level of outcome. Scandinavian Journal of Psychology 16, 273-279.

Marton, F. 1981. Phenomenography – describing conceptions of the world around us. Instructional Science 10 (2), 177-200.

Marton, F. 1998. Phenomenography: Exploring different conceptions of reality. D.M. Fetterman (Eds.) Qualitative approaches to evaluation in education. The silent scientific revolution. New York: Praeger, 176-205.

Marton, F. & Booth, S. 1996. The learner's experience of learning. In D. Olsen & N. Torrance (Eds.) The handbook of education and human development: New models of learning, teaching and schooling. Cambridge, Massachusetts: Blackwell Publishers Ltd, 534-563.

Marton, F. & Booth, S. 1997. Learning and awareness. Hillsdale, NJ: Lawrence Erlbaum Associates.

Marton, F., Dall'Alba, G. & Beaty, E. 1993. Conceptions of learning. International Journal of Educational Research 19 (3), 277-300.

Mathiassen, L. 1998. Reflective systems development. Scandinavian Journal of Information Systems 10 (1-2), 67-118.

McBurney, P. & Luck, M. 2007. The agents are all busy doing stuff! IEEE Intelligent Systems 22 (4), 6-7.

Merriam-Webster Online dictionary. 2007. [online] Webster's Revised Unabridged Dictionary. Available: http://www.merriam-webster.com [July 3, 2007]

Meyer, C. 1993. Fast cycle time: How to align purpose, strategy, and structure for speed, NY: Free Press.

Mill, J.S. (August 1, 2006a) [online] A system of logic, ratiocinative and inductive; being a connected view of the principles of evidence and the methods of scientific investigation, Vol. 1. (7th ed.) (Orig. 1868). Available: http://www.archive.org/details/asystemoflogic01milluoft [July 9, 2006]

Mill, J.S. (August 1, 2006b) [online] A system of logic, ratiocinative and inductive; being a connected view of the principles of evidence and the methods of scientific investigation, Vol 1. (7th ed.) (Orig. 1868). Available: http://www.archive.org/details/asystemoflogic02milluoft [July 17, 2006]

Miller, G.A. 1956. The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychological Review 63 (2), 81-97.

Miller, G. A., Galanter, E. & Pribram, K. H. 1960. Plans and the structure of behavior. New York: Holt, Rinehart & Winston.

Mingers, J. C. 1995. Information and meaning: foundations for an intersubjective account. Information Systems Journal 5 (4), 285-306.

Moreno, J. L. 1961. The role concept. A bridge between psychistry and sociology. American Journal of Psychiatry 118 (6), 518-523.

Mrosovsky, N. 1990. Rheostasis: The physiology of change. NY: Oxford University Press.

Muhr, T. 1995. ATLAS.ti, release 1.1E. In E. A. Weitzman & M. B. Miles (Eds.) Computer programs for qualitative data analysis. A software sourcebook. Thousand Oaks: Sage, 217-229.

Newell, A. & Simon, H. A. 1972. Human problem solving. Englewood Cliffs, NJ: Prentice-Hall.

Norman, D. A. 1981. Twelve issues for cognitive science. In D. A. Norman (Ed.), Perspectives on cognitive science. Hillsdale, NJ: Erlbaum, 265-295.

Norman, D. A. 1982. Learning and memory. San Francisco, CA: W. H. Freeman.

Norman, D. A. 2004. Emotional design. New York, NY: Basic Books.

Oatley, K. & Jenkins, J. 1996. Understanding emotions. Cambridge, MA: Blackwell Publishers.

Ohanian, H. C. 1989. Physics. (2nd ed.). NY: W. W. Norton.

Orlikowski W. J. & Baroudi, J. J. 1991. Studying information technology in organizations: Research approaches and assumptions, Information Systems Research 2 (1), 1-28.

Ortony, A., Clore, G. L. & Collins, A. 1988. The cognitive structure of emotions. NY: Cambridge University Press.

Osgood, C. E., Tannenbaum, P. H. & Suci, G. J. 1957. The measurement of meaning. Urbana: University of Illinois Press.

Patrikainen, R. 1997. Conception of human, knowledge and learning in class teachers pedagogical thinking (in finnish). University of Joensuu Publications in Education 36.

Paulsen, M. F. 2003. Online education and learning management systems - Global elearning in a Scandinavian perspective. Oslo: NKI Forlaget.

Passerini, K. 2006. Evaluating learning management systems: Leveraging learned experiences from interactive multimedia, International Journal of Web-Based Learning and Teaching Technologies 1 (3), 1-27.

Patterson, K. 2007. Storage capacity comparison of neural network models for memory recall. Crossroads, 14 (1), 8-12.

Pearson, C. S. 1991. Awakening the heroes within. Twelve archetypes to help us find ourselves and transform our world. NY: HarperCollins.

Piaget, J. 1971. The child's conception of the world. London: Routledge & Kegan Paul.

Posner, M. I. & Raichle, M. E. 1994. Images of mind. NY: Scientific American Books.

Raskin, J.D. 2002. Constructivism in Psychology: Personal construct psychology, radical constructivism, and social constructionism. American Communication Journal, 5 (3).

Renström, L. 1988. Conception of matter. A phenomenographic approach. Acta Universitatis Gothoburgensis. Göteborg studies in educational sciences, 69. University of Göteborg.

Resnick, L.B., Levine, J.M. & Teasley, S.D. (Eds) 1991. Perspectives on socially shared cognition. Washington, DC: APA.

Robey, D. & Markus, M. L. 1984. Rituals in system design, MIS Quarterly 8 (1), 5-15.

Rogoff, B. 1990. Apprenticeship in thinking. New York: Oxford University Press.

Rohrer, T. 2001. The cognitive science of metaphor from philosophy to neuroscience. Theoria et Historia Scientarum 6, (1), 27-42.

Rumelhart, D. & Norman, D. 1978. Accretion, tuning and restructuring: Three modes of learning. In. J.W. Cotton & R. Klatzky (Eds.), Semantic Factors in Cognition. Hillsdale, NJ: Erlbaum, 37-53.

Russo, N. L. & Stolterman, E. 2000. Exploring the assumptions underlying information systems methodologies: Their impact on past, present and future ISM research. Information Technology & People 13 (4), 313-327.

Sage, A. P. 1995. Systems management for information technology and software engineering. NY: John Wiley & Sons.

Schank, R. C. & Abelson, R. 1977. Scripts, plans, goals and understanding. Hillsdale, NJ: Erlbaum.

Schön, D. A. 1987. Educating the reflective practitioner. NY: Basic Books.

Senge, P., Kleiner, A., Roberts, C., Ross, R. B. & Smith, B. J. 1994. The fifth discipline fieldbook. London: Nicholas Brealey Publishing.Illeris, K. 2002. The three dimensions of learning, Denmark: Roskilde University Press.

Shakespeare, W. (July 1 2000a) [online] Timon of Athens. (Orig. disputed). Available: http://www.gutenberg.org/etext/2262 [March 12, 2007]

Shakespeare, W. (July 1 2000b) [online] Henry VIII. (Orig. est. 1613). Available: http://www.gutenberg.org/etext/2258 [March 13, 2007]

Shannon, C. E. 1948. A mathematical theory of communication. Bell System Technical Journal 27 (3 & 4), 379-423 & 623-656. Available: cm.bell-labs.com/cm/ms/what/shannonday/shannon1948.pdf [August 20, 2006]

Shuell, T. J. 1986. Cognitive conceptions of learning. Review of Educational Research 56 (4), 411-436.

Shuell, T. J. & Lee, C. Z. 1976. Learning and instruction. Monterey, CA: Brooks/Cole.

Shukumine, S. 1993. 概論. 日本: 国光印刷株式会社.

Sievänen, A. (2004). A matrixulation method for mapping an e-learning platform designer's conception of learning. In E. Cohen (Ed.) Proceedings of the Informing Science and Information Technology Education Joint Conference. Santa Rosa, CA: Informing Science Institute, 13-28.

Silveira, R. A., Gomes, E. R., Pinto, V. H. & Vicari, R. M. 2004. Intelligent learning objects: An agent based approach of learning objects. In J. C. Lester et al. (Eds.) ITS 2004, LNCS 3220, Berlin Heidelberg: Springer-Verlag, 886-888.

Simon, H. A. 1976. Administrative behavior. (3rd ed.). NY: The Free Press.

Simon, H. A. 1978. On how to decide what to do. The Bell Journal of Economics 9 (2), 494-507.

Simon, H. A. 1979. Rational decision making in business organizations. The American Economic Review 69 (4), 493-513.

Skinner, B.F. 1935. [online] Two types of conditioned reflex and a pseudo type. (Orig. 1935 in The Journal of General Psychology, 12, 66-77). Available: http://psychclassics.yorku.ca/Skinner/Twotypes/twotypes.htm [March 8, 2004]

Stalk, G. Jr. & Hout T. M. 1990. Competing against time: How time based competition is reshaping global markets. NY: Free Press.

Star, S. L. & Griesemer, J. R. 1989. Institutional ecology, 'translations' and boundary Objects: Amateurs and professionals in Berkeley's museum of vertebrate zoology, 1907-39. Social Studies of Science 19 (3), 387-420.

Stufflebeam, R. 1998. Representation and computation. In W. Bechtel & G. Graham (Eds.) A Companion to Cognitive Science. Malden, MA, USA: Blackwell Publishers, 636-648.

Svensson, L. 1997. Theoretical foundations of phenomenography. Higher Education Research & Development 16 (2), 159-171.

Säljö, R. S. 1979. Learning in the learner's perspective. I. Some common-sense conceptions. Reports from the Department of Education No. 76. Göteborg: University of Götebörg.

Tennenhouse, D. 2000. Proactive computing. Communications of the ACM 43 (5), 43-50.

Thagard, P. 1996. Mind: Introduction to cognitive science. Cambridge, MA: MIT Press.

The Pierre Berton Show. December 9, 1971. [online video] Interview with Bruce Lee. Available: http://www.cryosites.com/video/eZ0RF_QetSQ/Bruce-Lee- [April 15, 2006]

Thorndike, E. 1913. Educational psychology: The psychology of learning. New York: Teachers College Press.

Tsai, S. & Machado, P. 2003. E-learning, online learning, web-based learning, or distance learning [online] eLearn magazine. Available: http://www.eduweb.hu/pdf/stpm_hawaii.pdf [August 13, 2003]

Tuomi, I. 1999. Data is more than knowledge. Journal of Management Information Systems, 16 (3), 107-121.

Tyrväinen, P., Järvenpää, M. & Sievänen, A. 2003. On estimating the amount of learning materials - A case study. In O. Camp, J. Filipe, S. Hammoudi & M. Piattini (Eds.) Proceedings of the Fifth Conference on Enterprise Information Systems, Vol. 4., Dordrecht: Kluwer Academic Publishers, 127-135.

Vainionpää, J. 2006. Erilaiset oppijat ja oppimateriaalit verkko-opiskelussa. Tampereen Yliopistopaino Oy - Juvenes Print. Academic dissertation.

Van Maanen, J. 1979. The fact of fiction in organizational ethnography. Administrative Science Quarterly 24 (4), 539-550.

Van Rossum, E.J., Deijkers, R. & Hamers, R. 1985. 'Students' learning conceptions and their interpretation of significant educational concepts'. Higher Education 14 (6), 617-641.

Vygotsky, L. S. 1978. Mind in society – The development of higher psychological processes. Cambridge, MA: Harward University Press.

Watson, J. B. 1913. [online] Psychology as the behaviorist views it. (Orig. in Psychological Review 20, 158-177). Available: http://psychclassics.yorku.ca/Watson/views.htm [December 24, 2004]

Webster, N. 1913. [online] Webster's revised unabridged dictionary. Springfield, Mass: C. & G. Merriam Co (Merriam-Webster). Available: http://humanities.uchicago.edu/orgs/ARTFL/forms_unrest/webster.form.htm [October 30, 2007]

Welke, R. J. 1983. IS/DSS: DBMS Support for information systems development. In C. Holsaple & D. A. Whinston (Ed.), Database Management: Theory and Application. Dordrecht: Reidel, 195-250.

Welke, R. J. & Konnsynski, B. 1982. An examination of the interaction between technology, methodology and information systems: A tripartite view. DataBase 13 (1), 41-52.

Wittgenstein, L. J. J. 1958. The Blue and Brown Books. Oxford: Blackwell Publ.

Yarusso, L. 1992. Constructivism versus objectivism, Performance & Instruction, 31(4), 7-9.

Yin, R., K. 1989. Case study research: Design and methods. Beverly Hills, CA: Sage.

Åkerlind, G. 2005. Variation and commonality in phenomenographic research methods. Higher Education Research & Development 24 (4), 321-334.

APPENDIX I

Central ideas of various CoL from the earlier studies related. Although the earlier research is listed showing the uniformity between conceptions, the table does not express the nuances and ideas in great detail.

Author / Central idea	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
Gagne (1965)	x																		
Rumelhart & Norman (1978)				x															
Shuell and Lee (1976)		x																	
Säljö (1979)				x	x	x	x	x											
Langley and Simon (1981)									x										
Van Rossum et al. (1985)				x	x	x	x	x											
Marton et al. (1993)			x	x	x	x	x	x											
Cliff (1998)			x	x	x	x	x	x		x									
Isomäki & Häkkinen (2001)	x												x	x	x	x	x	x	x
Ileris (2002)		x							x		x	x							

A	Formal: signal learning, stimulus-response learning, chaining, verbal association, multiple discrimination, concept learning, principle learning, and problem solving
B	A change in an individual 's behavior or ability to do something, a stipulation that this change must result from some short of practice or experience, and a stipulation that the change is an enduring one
C	Changing as a person. Through developing insights and points of view the learner sees the world differently, as well as an agent of change, responsible for their own learning
D	Understanding where the individual develops some meaning from their learning, they start to see things in a different way or develop a view
E	Increasing one's knowledge, ready-made facts and information consumption
F	Memorizing and reproducing, learning is devoted to reproducing facts and information for a specific purpose
G	Applying, where the learner applies what is learned as the need arises e.g. driving skills or PIN numbers
H	Seeing something in a different way, gaining new perspectives
I	Process that modifies a system to improve, more or less irreversibly, its subsequent performance of the same task or of task drawn from the same population
J	Moral obligation or service
K	Integrated part of human life and survival potential and is libidinous in nature
L	Entity which unites a cognitive, an emotional and social dimension into one whole
M	Happens with action and with explorative strategies, contributing recollection
N	Based on affective characteristics, attitudes regulate learning
O	Time-consuming
P	Different due to age and gender
Q	Initiated by new "technology", people learn either with enthusiasm or under compulsion
R	Dependent on the context, occurs in the working community
S	By-product of working processes, e.g. client organization's users learn at same time when participating in systems development