JYVÄSKYLÄ LICENTIATE THESES IN COMPUTING

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Leena Hiltunen

Web Course Design with Topic-case Driven Methodology

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Editor
Tommi Kärkkäinen
Department of Mathematical Information Technology, University of Jyväskylä

ISBN 951-39-2264-2 (pdf)

ISBN 951-39-2325-8 (nid.)
ISSN 1795-9713

Jyväskylä University Printing House, Jyväskylä 2005

ABSTRACT

Hiltunen, Leena
Web course design with topic-case driven methodology
Jyväskylä: University of Jyväskylä, 2005, 115 p.
(Jyväskylä Licentiate Theses in Computing,
ISSN 1795-9713; 1)
ISBN 951-39-2264-2

Topic-case driven methodology for web course design and realization was introduced in ICNEE 2004 (Hiltunen & Kärkkäinen 2004). The approach is based on software engineering metaphors for capturing the necessary steps for creating web courses using a content-based development method. Before introducing this methodology this thesis discusses first about learning and teaching, and how these will change while moving from traditional classroom environment to online learning. These issues are essential in pedagogical design which is one of the main differences in the proposed methodology compared to other existing design models which have been used in web course design. These existing models are briefly reviewed next in this thesis. After this some essential quality issues are discussed and some new quality indicators are suggested, and finally, this thesis introduces the topic-case driven methodology for Web course design. This thesis introduces also results from a case study where students of computer science teacher education study line used the proposed methodology in real web course design at the University of Jyväskylä, Finland. Results from this case study concerning the presented methodology and its utilization in Web course design are very encouraging. At the end, this thesis shortly considers possibilities for constructing and maintaining web course repository and corresponding training programs.

Keywords: online education, online pedagogics, web course, virtual learning environment, design, educational technology

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ACKNOWLEDGEMENTS

First of all, I would like to express my gratitude to Professor Tommi Kärkkäinen. Without his patience this work could not have started – or ended.

This thesis includes a case study that was carried out during the autumn, 2004 with a group of eager students. They all helped me to see the need for this kind of research, and I already received a reward from them – positive feedback from the Web Course Design and Implementation course.

I wish to thank Prof. Päivi Häkkinen from the Institute for Educational Research (University of Jyväskylä) and Prof. Marja Kuittinen from the Department of Computer Science (University of Joensuu) for their careful reading of the thesis and for their valuable comments and remarks. Gary Littler deserves special thanks for his linguistic comments.

Thanks to Antti Auer, Markku Närhi, Hanna Seuranen, and Kekke Hyvämäki from the Virtual University project. Antti has introduced numerous interesting articles, issues and topics to me. Markku, Hanna and Kekke helped me a great deal with Optima and especially with streamed videos. I also got four months salary at the end of 2001 from the Virtual University project.

Discussions around the coffee table at work with colleagues have been most entertaining and relaxing, and occasionally even educational. Thanks to Jaana, Kirsi, Hilkka, Jonne, Jukka-Pekka S., Antti-Juhani, Sami, Mika W., Tommi H., and Lari.

I have got a lot of precious tips from my old study mates, Salme and Tuija, and we have had pleasant lunch breaks and badminton games besides research work. Thanks a lot, girls!

I would like to express my gratitude to my parents, Saara and Aarre, and my brothers, Teijo and Tero. All these years, you kept having faith in me – thank you! I hope you won't lose you faith in me in the future either – there is one more step to go :-)

Most of all, I wish to express my warmest gratitude to my husband, Kaitsu, and our three sons, Aleksi, Teemu and Tuomas. They have kept me balanced, without them my life would have been quite boring with books and articles. Besides, I love you!

Jyväskylä, September 14, 2005.

Leena Hiltunen

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1 INTRODUCTION

Learning today is no longer confined to institutions such as schools, colleges, and universities. New technologies provide us with new possibilities: easier access to information and better opportunities for lifelong learning – also online. Still, there are problems to overcome: even nowadays web courses are too often simply based on exporting traditional written course materials to the web without proper planning and pedagogical design. Also, technical decisions may already have been made by someone else, e.g., if only a particular platform can be supported in the organization. Furthermore, usually testing and evaluation of the web course are just forgotten and educators are satisfied to have something up and running. Such straight forward approaches do not support students in their individual learning styles which lead them to poor learning experiences and an unwillingness to take part in the next web course. We need more than just "translation" of books and lectures into an electronic format (Bork 1986). We need online courses that teach, not just web pages that present information (Schank 1993). There is a need for courses that base more on learning about concepts (Schank 1998). Moreover, students need to be more active while they learn; not just passive "TV-viewers" (Schank 1998). Students will learn by doing, by accomplishing tasks; not by being told (Schank 1993 and 1998).

To support lifelong learning we need more quality in an online learning context – instead of using new technology to do the same old things differently, we should focus on doing new things in new ways (e.g., McDonald 2002). No more "page-turning or scroll-down architectures" where a learner just presses the button for the next page or scrolls down the screen (e.g., Schank 1993). As Twigg (2001a) points it out, *"we need to be more thoughtful about course design so that we include structures and activities that work well with diverse types of students"*.

The creation of digital content is regarded as the next wave in the development of the information society (e.g., Finnish Ministry of Education 2002; Council of European Union 2000). At the core of content production – independent of the purpose of the material to be produced – one should employ a content creation and development process, which, at its best, supports structural and incremental development and, thus, also reusability of the resulting materials as suitable learning objects (Jacobsen 2001; Catenazzi & Sommaruga 2002; LOM 2002).

There are, however, no unified practices for web course design. There are, however, some reported experiments and trials related to some parts of individual courses (e.g., White 2000; Montilva 2000). One can also find some design process descriptions or models for web course creation that are either related to Software Engineering (e.g., Baloian et al. 2001) or Instructional Design (e.g., Anglada 2002). However, all of the existing models fail to describe a development process that allows for the integration of digital material with pedagogical knowledge as well as support when learning with communication and cognitive tools (Multisilta 1997). Notice, as described e.g. by Pekkola (2003), that also CSCW (Computer Supported Cooperative Work) of learning groups should be based on (pieces of) documents for further elaboration.

Humphrey (1998) emphasizes the effective planning and quality management in software engineering. He also highlights the use of improved methods. Each of these is a useful principle in web course design too. Furthermore, Hoover (1998) applies John's model for human-computer interaction (John et al. 1992) in their software engineering based TAP-D model, where, *"software developers apply domain knowledge, computing theory, and software development techniques to specify, design, and evaluate software for a particular application"*. This same model can also be applied in web course design because not only does content-based knowledge but also pedagogical theories and practices during the learning process (e.g., authentic assignments) influence the design of a web course. Moreover, in Boehm et al. (1998), an extension of the popular Spiral Model of software development has been used to design, implement, evaluate and improve software engineering core courses for the USC MS-degree program. Altogether all of these examples show that software engineering principles and practices are the most popular source of web course and related curricula design metaphors.

The most fundamental metaphor in this work is finding that the content of a web-based course is similar to the functionality of a computer program: they are both drivers for further development, presenting functionality and contents in the best possible way to all users or students to enhance usage or learning. In software engineering a structured way for presenting the general functionality of an application to be implemented are the use-cases (Jacobson et al. 1992 & 1999). Together with the use-case diagram they capture and present, in a hierarchical way, the so-called functional requirements of a software system.

The purpose of this work is to describe a development process for web course design that, first, allows well-managed integration and incorporation of structural and multigranular digital material with pedagogical knowledge as well as, e.g., communication and cognitive tools. Secondly, it utilizes metaphors from software engineering, i.e. Unified Process (Jacobson et al. 1999). In particular, the presented methodology naturally supports the utilization of a large, possibly distributed team of domain experts for creating the key contents. Finally, it supports structural and incremental development and reusability of the resulting materials as suitable learning objects.

In brief, the goal of this research is to define new web course designing methodology that will also support blended learning as well. This goal leads us to the research problems of this work.

1.1 Research problems

The research problems of this work are defined as follows:

1. How to get more quality in online learning and how to measure it?

2. Is it possible to define a unified process for web course design?

3. How well does this kind of new design methodology work in practice?

1.2 Research methodology

This research work is divided into three separate parts: *qualitative research*, *constructive work*, and *a case study*.

Qualitative research is based upon literature reviews and covers the first research problem. This part of the research focuses on four different aspects:

- *Pedagogical background:* how learning and teaching changes while we move from traditional classroom into the virtual learning environment, and how these should be taken into account in web course design.
- *Designing methodologies:* What kinds of theories and methods have been used, and which of these can be generalized in online learning. Moreover, how some improved model could help one to develop better web courses.
- *Learner-centered design:* how learning online can be supported and what issues have to be considered while implementing usable, learnable and learner-centered virtual learning environments.
- *Quality issues:* what quality means in online learning and how to evaluate or measure it.

The information was used as a background in **constructive work** to solve the second research problem, and to form and introduce a new web course designing methodology called *'Topic-case driven methodology for web course design'*. This new methodology utilizes metaphors from software engineering; particularly it uses the *use-case* as a key metaphor behind the introduction of a basic element of contents called a *topic-case*. In the proposed approach the topic-cases carry the whole web course development process from the initial topics and supporting material through to the pedagogical and technical considerations into the final realization and assessment.

A case study concentrates on solving the third research problem. The case study was organized with a group of computer science students during the autumn 2004 when they used the methodology in their own web course design during a course they were participating in. The course is called 'Web Course Design and Implementation'. Students were observed and interviewed off the record from time to time while they tested this new web course design methodology in practice. A questionnaire was developed in the Optima learning environment and students who participated in this course were asked to fill in a questionnaire to categorize different aspects of the case. Some parts of the questions in the questionnaire were statistical multiple-choice questions and the rest were more analytical essay questions. The answers were tabulated and analyzed statistically or qualitatively. Students kept learning diaries as part of the course evaluation. These learning diaries were also used as background material for the analysis. The analyzed results from this case study are presented later in this thesis.

1.3 About the content of this thesis

The content of this thesis is structured as following: **Chapter 2** discusses learning and teaching, and how it will change while moving from a traditional classroom environment to online learning. Before designers can design usable and learnable learning environments (e.g., Horila et al. 2002), they have to understand the basic rules of learning and teaching (Manninen & Pesonen 2001). These issues are essential, especially, in pedagogical design which is one of the main differences in this proposed methodology compared to other existing ones. As a baseline **Chapter 3** reviews some of these existing design processes and models which have been used so far in web course design. **Chapter 4** discusses learner-centered design and how to support and promote learning online with cognitive and communication tools.

Chapter 5 discusses quality issues in online learning. High quality of online learning is the biggest unsolved problem in web course design that the proposed topic-case driven web course design methodology, introduced in **Chapter 6**, is also trying to solve. **Chapter 7** describes and introduces results from the study case where the proposed methodology was tested with a group of graduate students from the computer science teacher education study line.

Students used the proposed methodology in real web course design at the University of Jyväskylä. **Chapter 8** introduces the possibilities for constructing and maintaining a web course repository and corresponding training programs by using the proposed approach. Each of these chapters has its own summary at the end, and **Chapter 9** summarizes the contributions and conclusions in the thesis as a whole.

2 PEDAGOGICAL BACKGROUND

The basis of designing any educational or learning environments should always be some kind of model or method in regards to learning and teaching (Manninen & Pesonen 2001). The whole design process can be based on some specific learning or teaching theory, but the selection of the used method should always be based on the evaluation that it is the best or most suitable choice in that particular learning situation (Manninen & Pesonen 2001).

Manninen & Pesonen (2001) remind us that before designers of learning environments can fully take advantage of all of these educational methods, they should be able to recognize and adapt the basic rules of learning. This chapter is concerned with these basic rules of learning; how students are able to improve their understanding by being able to learn and recognize their individual learning style(s); what actually is learning, and how would it differ while we move from the traditional classroom into a virtual learning environment. Furthermore, different ways of supporting and promoting learning, especially, in a virtual learning environment are discussed, and educational methods for online learning as well as teaching computer science on the Web are introduced. Finally, the chances in the role of the teacher are discussed as well as changes in assessment.

2.1 Different learning styles

Since the times of Socrates, educators have realized that they would never be able to teach students everything that they would possibly need to know in life.

They can only prepare students for a lifetime of learning by teaching the general skills and strategies that can be applied to a variety of problems and learning situations (Thiede 2003). At the same time, there are a lot of learners who often thinks that *"I am not able to learn this or that"*. Besides, they keep giving all kinds of excuses to justify their thoughts, e.g. *"I'm not mathematical enough"* or *"Even my mom couldn't learn this – it runs in the family"*. Of course, it is much easier to give up and tell yourself that you are just not able to learn something that you should be able to. Learning is not always easy, but we can all learn how to learn (Vakkuri 1998).

Learning to learn means that students start to recognize their own metacognitive skills. In other words, students become aware in their own way of approaching a learning task and understanding its content, and realizing that there are also alternative ways (Vakkuri 1998; Marton 1988). Furthermore, students become aware of the usefulness of some knowledge and skills to perform certain tasks, to understand new facts, or to solve problems (Vakkuri 1998). On the other hand, learning to learn means that students learn to utilize the right kind of learning strategies in different learning situations and that way are able to achieve the desired learning goals more easily (Thiede 2003).

2.1.1 Recognition of learning style

Learning style is the way that one prefers to learn. Although previous experiences do have an effect, it still has nothing to do with intelligence or what skills have been learnt (Schmeck 1998a; Jester 2000). It is the individual way how the brain works most efficiently when learning new information (Jester 2000).

Recognition of learning styles helps students to learn better. Every student has an individual learning style, and some of the students are even able to adapt new, more suitable learning styles in different learning situations (Dunn et al. 1989; Leino & Leino 1990). At the same time, according to Schmeck (1998b), educators can do little to change personality and a students' cognitive learning directly. However, by designing learning environments that support different learning styles, educators can help all students to learn better in their own natural way (Leino & Leino 1990).

There are several characterizations of learning styles. One is the division as follows (e.g., Jester 2000, and Doyle & Rutherford 1984):

- **Visual learner** - learns best when information is presented visually and in a written language format, or in a picture or design format; learning through seeing information or objects.
- **Auditory learner** - learns best when information is presented auditory in an oral language format; learning through hearing.
- **Tactile/kinesthetic learner** - learns best when physically engaged in a "hands on" activity, or by manipulating learning materials; learning through reshaping the information or objects.

No matter how this division is made, it is still widely accepted that none of the learning styles is better or worse than the others (Lappalainen 1995; Dunn et al. 1989). Moreover, as Doyle & Rutherford (1984) remind us that learning styles are not the only characteristics that have an effect in a learning situation. There are also other issues to be concerned with, like characteristics of the subject itself, nature of the learning materials, knowledge and skills of the teacher, as well as the personality of the teacher. If students have some problems with online learning, we can not just conclude *"that online learning is more suitable for one type of student than another"*, instead of that *"we need to think more creatively about how to develop course designs that respond to a greater variety of learning styles"* (Twigg 2001a).

An instructor's role is huge in this case; it is his/her job to teach students how to learn! Educators should be able to recognize how each student tends to concentrate: alone, with others, with certain types of instructors, or in some combination of these (Dunn et al. 1989). Moreover, instructors should be aware of the ways through which students remember difficult information the most easiest way: by hearing, speaking, seeing, manipulating, writing or taking notes, experiencing, or a combination of these (Dunn et al. 1989). Instructor's should offer students different kinds of stimuli, guide them to use the right kind of learning strategies, and make sure that students learn all that is essential in their own way (Vakkuri 1998; Thiede 2003). Before utilizing the best learning strategies, students should be aware of their metacognitive skills, and understand the role of metacognition in learning. Furthermore, they should be able to get information about the utility of the strategy, and when and how to use it (Pressley et al. 1984). According to Thiede (2003), there is a significant relationship between learning the outcome and knowledge of specific strategies. Students with more knowledge about a strategy have performed better in tests. Ideally, students would be able to monitor the effectiveness of a used strategy and change strategies if necessary.

2.2 Basic rules of learning

To be able to design learning environments where different kinds of learning styles and strategies can be supported instructors have to be aware of the basic rules of learning, like what exactly is learning and how to support and promote it while teaching.

2.2.1 What is learning?

Learning can be defined in various ways, e.g., as follows:

- Learning can be considered *"as 1) increasing the amount of knowledge, 2) making a mental note, 3) providing facts, skills, and methods, 4) abstracting meanings, or 5) constructing meanings"* (Uusikylä & Atjonen 2000; p. 124).

- Learning is *"a relatively permanent change in a person's knowledge or behavior due to experience"* (Mayer 1982; p. 1040).
- Learning is *"a persisting change in human performance or performance potential"* and that *"a change in performance must come about as a result of a learner's interaction with the environment"* (Driscoll 1994; pp. 8-9).
- Learning is *"a process that builds on or modifies understanding, capacities, abilities, attitudes and propensities in the individual"* (Inglis et al. 1999; p. 104).
- Learning is an enduring *"change in an individual's behavior or ability to do something"*, and *"this change must result from some sort of practice or experience"* (Shuell 1986; p. 412).

Despite the differences among these definitions, they all share the same key word that is *change*. To learn is to change (or have the capacity to change) ones level of ability or knowledge. Learning is measured by the amount of change in an individual's level of performance or behavior. (Newby et al. 1996)

According to Shuell (1986, 1990a & 1990b), learning has also been defined as *"an active, constructive, cumulative, and goal-oriented process that involves problem solving"*. Moreover, *"a problem solving metaphor is most consistent with current conceptions of meaningful learning"* (Shuell 1990b). Meaningful learning has been defined by Jonassen (1995).

2.2.2 Meaningful learning

Learning should always be meaningful. Originally, Jonassen (1995) defined meaningful learning with seven qualities: *active*, *constructive*, *collaborative*, *intentional*, *conversational*, *contextualized*, and *reflective*. In their own research Ruokamo & Pohjolainen (1999) added one more quality into the list, *transfer* (they also combined conversational and collaborative quantities as a one). All of these eight qualities are defined as follows (Figure 1):

- **Active** - Learners are active participants when processing information, where they are responsible for the results.
- **Constructive** – Learners compose new knowledge by combining new information into their prior knowledge in order to make sense or meaning.
- **Collaborative** – Learners work together; exploit each others skills by observing or modeling, and by providing social support and giving feedback to each member.
- **Intentional** – Learners set cognitive objectives for their own learning and are actively trying to achieve these goals by focusing their activities in the right direction; learners learn to guide their own learning.
- **Conversational** – Learning is a social and dialogical process in which learners are able to utilize the knowledge of other members of the learning community during the knowledge building process.

- **Contextualized** – Learning tasks are authentic as being situated in some meaningful real-world situation, or as being simulated through some case-based or problem-based learning environment.
- **Reflective** – Learners externalize what they have learned by reflecting their own learning process and decisions made during the process.
- **Transfer** – Learners are able to transfer their learning from one situation or context into another, and adapt their skills and knowledge for new situations.

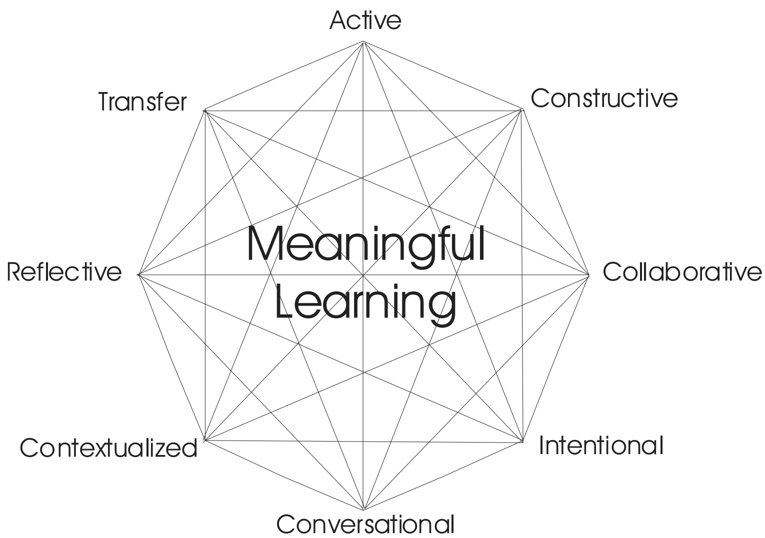

FIGURE 1 Meaningful learning; modified from Jonassen (1995) and Ruokamo & Pohjolainen (1999)

These defined quantities of meaningful learning form a solid base for the learning process.

2.2.3 Phases of the perfect learning process

According to Engeström (1988) a perfect learning process can be divided into six phases where learner as a researcher is looking for some universal explanation for his/her problem. Phases are defined as follows (Engeström 1988; see also Figure 2):

- **Motivating**: stirring of motivation to the topic that will be learnt; the goal is to become aware of conflict between new mental models and to learn the student's own former data structure; students will become conscious of the conflict when he/she tries to solve a problem which overruns the former knowledge.
- **Orientation**: formulation of structured and cognizant pre-conception (base of orientation) which explains principles and data structures that are needed to be able to solve the problem.

- **Internalization**: reconstitution of the former mental model with the help of new knowledge; student proportions new knowledge with former, and interprets and absorbs knowledge into a new model.
- **Externalization**: an application of the knowledge to solve real life concrete problems; testing and evaluation of learnt principles.
- **Evaluation**: student him/herself considers critically the validity and reality of the learnt mental model.
- **Control (or self-evaluation)**: student evaluates own learning, own ways of structure and interprets knowledge, and especially own ways to solve problems based on new knowledge; the goal is to improve own learning strategies, to analyze own learning results and to recognize errors and strengths.

The whole learning process is based upon a student's personal motivation (see Figure 2). If students are not sure why they have to learn something, they are not going to learn the desired things (Vakkuri 1998); meaningful learning also needs some domain.

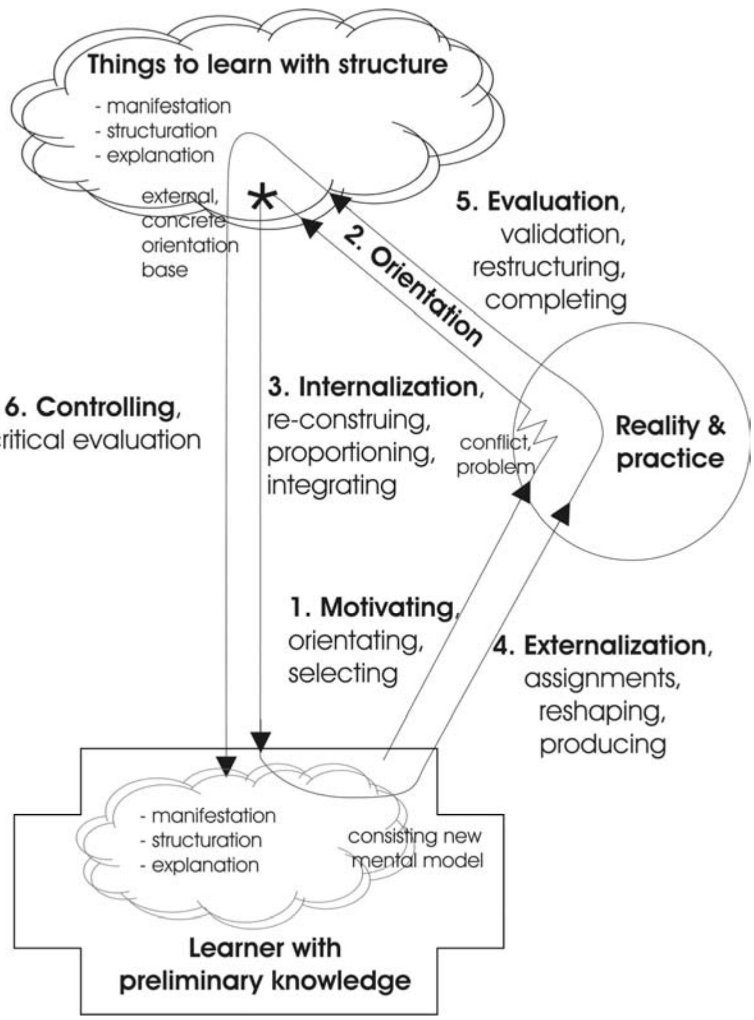

FIGURE 2 Perfect learning process by Engeström (1988)

2.2.4 Generic domains of (adult) learning

By transforming knowledge interests presented by Habermas (1971 & 1972) to learning domains, Mezirow (1981) presents three generic domains of (adult) learning:

- **Instrumental learning:** the objective is to increase empirical knowledge and "technical rules" on how predictions about observable events can be proved correct or incorrect and what is or is not an appropriate action; e.g., a student learns to use the computer
- **Communicative learning:** the objective is to increase knowledge on binding consensual norms that define reciprocal expectations about behavior and that must be understood and recognized; e.g., learning in negotiations, instructional situations and co-operation
- **Emancipatory learning:** the objective is to increase the interest and knowledge in self-knowledge, self-reflection and self-awareness

Learning is often seen as an instrument; to be able to manage different things, people have to adopt different knowledge and skills (Engeström 1988). For example, in distance learning students have to learn first how to use the learning environment itself before they are able to start learning the content. Similarly, instructors have to study first how people learn before they are able to design effective learning environments.

Communicative learning is usually seen as a natural thing to happen, but it can also be willfully supported by different communication tools (Multisilta 1997). According to Engeström (1988), learning strategies and the learning of content itself can remarkably be promoted with communication between students. Especially, students will motivate and orientate each other while they study in pairs or in small groups.

Emancipatory learning is seen as a unique way of learning for adults; adults are able to take advantage of their previous experiences (Ahteenmäki-Pelkonen 1997). Cranton and Cohen (2000) define emancipatory knowledge as follows: *"Emancipatory knowledge is the personal, subjective knowledge of one's self, acquired through critical self-reflection. It leads to a personal empowerment. An individual who critically questions his/her values engages in a subjective activity unique to him/her. Through emancipatory knowledge, we free ourselves from the constraints of uncritically assimilated assumptions."*

2.2.5 About learning theories

Learning has always been seen through a learning theory. Some of these theories have been formed during the centuries, and some are quite new. They have had ups and downs; some of them have lost their supporters while new ones have arisen. The three most important trends of learning theories have been behaviorism, cognitivism, and constructivism. Ertmer & Newby (1993) have compared these three learning theories in one of their articles from an instructional design perspective (Table 1).

Each of the presented learning theories provide structured foundations for planning and conducting instructional design activities, and support a different approach to teaching (Ertmer & Newby 1993). As Ertmer & Newby (1993; p. 51) point it out, *"learning theories are a source of verified instructional strategies, tactics, and techniques. Knowledge of a variety of such strategies is critical when attempting to select an effective prescription for overcoming a given instructional problem"*. Moreover, by having an adequate repertoire of strategies available and knowledge of when and how to use each of them, designers are able to provide the best instructional strategy that helps the learner to solve the given problem or to perform the required task with the desired outcome (Ertmer & Newby 1993). Furthermore, it is also essential to be able to integrate the selected strategy with the given instructional context with specific learners, i.e. we are able to support different learners with different learning styles (see Section 2.1).

TABLE 1 Comparison of critical features of three learning theories from an instructional design perspective (Ertmer & Newby 1993)

	Behaviorism	**Cognitivism**	**Constructivism**
Occurrence of learning	Changes in the form or frequency of observable performance; proper response to the presentation of a specific environmental stimulus	Discrete changes between states of knowledge; what learners know and how they come to acquire it	Creating meaning from experience; personal interpretations of the world based on individual experiences and interactions
Factors influencing on learning	Assessment of the learners to determine at what point to begin instruction as well as to determine which reinforces are most effective for a particular student; arrangement of stimuli and consequences within the environment	Instructional explanations, demonstrations, illustrative examples and matched non-examples are instrumental in guiding students; corrective feedback	Learning in a context or situation in which the knowledge is about to be used; learning in realistic settings; learning tasks are relevant to the students' lived experience
Role of memory	Learned issues are "habits"; readiness to respond is the result of periodic practice or review; forgetting means "not used"	Information is stored in memory in an organized, meaningful manner; tools and techniques that help learners to organize new information in some optimal way to prior knowledge	Providing of means to create novel and situation-specific understandings by "assembling" prior knowledge from diverse sources appropriate to the problem in hand

(continues)

TABLE 1 (continues)

	Behaviorism	Cognitivism	Constructivism
Best explained types of learning	Learning that involves recalling facts, defining and illustrating concepts, applying explanations, and automatically performing a specified procedure	Learning that involves reasoning, problem-solving, and information-processing	Effective for the stage of advanced knowledge acquisition, where initial misconceptions and biases acquired during the introductory stage is discovered, negotiated, and modified and/or removed
Relevance to instructional design	An emphasis on producing observable and measurable outcomes in students; pre-assessment of students to determine where instruction should begin; mastering early steps before progressing to more complex levels of performance; use of reinforcement to impact performance; use of cues, shaping and practice to ensure a strong stimulus-response association	Emphasis on the active involvement of the learner in the learning process; use of hierarchical analyses to identify and illustrate prerequisite relationships; structuring, organizing, and sequencing information to facilitate optimal processing; creation of learning environments that allow and encourage students to make connections with previously learned material	An emphasis on the identification of the context in which the skills will be learned and subsequently applied; learner control and the capability of the learner to manipulate information; the need for information to be presented in a variety of different ways; supporting the use of problem-solving skills that allow learners to go "beyond the information given"; assessment focused on transfer of knowledge and skills
Structuration of instruction	Instruction is structured around the presentation of the target stimulus and the provision of opportunities for the learners to practice making the proper response; use of cues and reinforcement	Instruction must be based on a student's existing mental structures, or schema, to be effective; learners must be able to connect new information with existing knowledge in some meaningful way	Meaning is created by learner: learning objectives are not pre-specified nor is instruction pre-designed; The role of instruction is to show students how to construct knowledge and to promote collaboration with others

Recently instructors have only used models and methods based on constructivism while designing new learning environments, but one should notice that new technologies enable new kinds of educational methods and new ways to utilize these (Manninen & Pesonen 2001).

In these different learning theories it is the learning situation that diverge the most; there is a contrast between the teacher-centered and learner-centered learning environment. Next these different approaches are compared (see Table 2) based on "things", people and processes (Connelly & Clandinin 1988).

TABLE 2 A contrast between the teacher-centered and learner-centered learning environment; modified from Knowlton (2000)

	Teacher-centered	Learner-centered
Pedagogical orientation	Behaviorism or positivism	Cognitivism or constructivism
"Things"	Teacher introduces "things" and suggests the implications of those things.	Both teacher and learners introduces "things", and both offer interpretations and implications.
People	Roles of teacher and student are regimented: the teacher disseminates knowledge, and the learner reflects that information.	Roles of teacher and learner are dynamic: the teacher and learner are a community of learners. The teacher serves as coach and mentor; the learners become active participants in learning.
Processes	Teacher lectures while student take notes.	Teacher serves as facilitator while learners collaborate with each other and the teacher to develop personal understanding of content.

In a teacher-centered learning environment the teacher introduces the specific **"things"** to learn, issues that are worthy of being studied, and learners are told how to interpret them; learners just memorize things as being introduced by the teacher (Kauchak & Eggen 1998). In learner-centered learning environment learners find issues that are relevant to create knowledge and understanding by themselves. "Things" are tools that learners need while making meanings actively (Jonassen et al. 1995).

In a teacher-centered environment **people** play roles that are regimented and standardized; the teacher is the "giver of knowledge" offering a stimulus to which students respond (Knowlton 2000; Kauchak & Eggen 1998). In a learner-centered environment learners are active participants developing an understanding of the course materials. The teacher's role is recast; the teacher is a coach, counselor, and mentor (Knowlton 2000).

In a teacher-centered environment learning-teaching **processes** go as follows: the teacher assumes that *"structure can be modeled and mapped onto the learner"* (Jonassen et al. 1995); knowledge is "transferred" from teacher to learner through one-way communication. A lecture is seen as the most efficient way to teach while learners listen, take notes and receive the information (Knowlton 2000). A learner-centered approach requires collaboration and dialogue among students and the teacher (Kearsley & Shneiderman 1998; Jonassen et al. 1995; Savery & Duffy 1995). Learners are actively constructing their own knowledge by being engaged in authentic real-life activities (Jonassen et al. 1995).

2.2.6 Learning in distance – is there a significant difference?

Even though, when we move from the traditional classroom environment into the virtual learning environment, learning is basically still the same; learning still means changes in one's level of ability or knowledge, and is still measured by the amount of change in an individual's level of performance or behavior (see Section 2.2.1). Learning should still be meaningful (Section 2.2.2.) and the whole learning process bases itself on the student's own motivation (Section 2.2.3). Learning to learn and recognition of one's own learning style are even more importance in the virtual learning environment than in the traditional classroom, because courses should be more learner-centered (Section 2.2.5), and learners are expected to be responsible for their own learning, self-motivated and disciplined, and independent seekers of knowledge (Mäki-Komsi 1999; Canada 2000). Different learning styles can quite easily be supported with virtual learning environments; learning materials can be presented in different forms: videos, animations, pictures, audio, charts, text, rehearsals, drillings, assignments, etc., and different kinds of teaching methods can be adapted, e.g., experiential learning (Blank et al., 2003; Pimentel, 1999).

Differences in learning in a virtual learning environment appear in the requirements that are set for the learner him/herself. According to Mäki-Komsi (1999), online learning sets up a whole **new set of requirements for informational abilities and skillfulness**, e.g.

- abilities to seek, use, adapt, criticize, process and yield information, and differentiate essential knowledge from the unessential
- ability to build new mental models based on the old ones
- ability to co-operate and co-learn together with a teacher and other students
- ability to accept oneself as a learner
- ability to choose learning goals and strategies by oneself
- ability to evaluate own learning process by oneself
- aptitude for self-regulation, methodicalness, flexibility and explicitness

Furthermore, learners should have internal motivation, and he/she should be initiative, independent, creative and reflective (Mäki-Komsi 1999). Moreover, learners have to take more responsibility, adapt new learning environments, adjust to new contexts, know how to participate, and stimulate their own curiosity (Yang & Cornelious 2005). There is also **more diversity among distance learners** because they are able to take a part in any distance learning course they want, and where they want. There can be differences, e.g., in gender, in ethnic and cultural backgrounds, learning experiences and qualifications, in working experiences, in professional self-concepts, family backgrounds and commitments, and in age (Dzakiria et al. 2004). On the other hand, disabilities may be hidden in virtual interaction (Blake 2000).

Furthermore, according to Palloff & Pratt (1999), online learning brings up **a whole new set of physical, emotional and psychological issues** along with the educational issues, e.g., physical problems that can be experienced as the technology is used extensively, or students may get psychological addiction to the technology. Furthermore, in the traditional classroom a student may be physically present, but psychologically absent without the teacher even noticing it. In a virtual learning environment absence is noticeable. A student who suffers from performance anxiety in the face-to-face classroom may be more comfortable online and more active in responding to other students.

There are also **huge differences in social aspects of learning**. According to Palloff & Pratt (1999), we need to deal with a virtual world in which students cannot see, hear, or touch the people with whom they are communicating. We cannot see the facial expressions and body language that help us gauge responses to what is being discussed, and we cannot hear voices or tones of voice to convey emotions, because instructors and students are represented by text on the screen. We need to use more descriptive and explanatory language, good instructions that tell exactly what is expected to do, although some of our emotions can be expressed, e.g., with smileys. Moreover, there are also differences in the sense of "synchronous presence"; there is social distance between all participants (a sense that a group is working together in real time). This leads us to the need for social connections which are made through the sharing of ideas and thoughts (Palloff & Pratt 1999). If teachers are able to lessen this social distance between student and teacher, students' satisfaction will be higher (Arbaugh 2001).

In virtual learning environments **learning is mostly carried out without a teacher being physically present**. With careful pedagogical design students can be guided to be more self-reflective and to follow the desired learning process. Possible problems can be predicted during the implementation by supporting different learning strategies and styles (Nokelainen & Sointu 2003), and with well-defined and unambiguous instructions; the more the students are required to study independently the better the guidance and instructions should be included into the content itself (Nokelainen & Sointu 2003). Lack of face-to-face communication can be substituted by online discussions in chat and discussion boards or via online video conferencing (Blake 2000). In a virtual learning environment tutoring and different kinds of supporting systems became more important.

There are also **a lot of requirements for the virtual learning environment itself**. Learning environments should spur students to be active and responsible for their own learning (development of self-instructed learning manner), problem-based, context-based, and integrate different fields of knowledge. Moreover, it should spur students to collaborate and socially interact, improve dialogue, argumentation, and thinking skills, as well as students' reflective and metacognitive abilities. (Mäki-Komsi 1999)

However, **technology is just a tool**; virtual learning environments should be designed in a way that learning to use the technology does not take too much attention, and the focus should be on learning the content itself. As Jonassen (1995) says, technological solutions *"should be used as facilitators of* *thinking and knowledge construction"*. Instructors should pay attention to learning that occurs through the use of the medium itself (Palloff & Pratt 2001). This requires that designers are aware of the basic rules of learning, so that they are able to optimize learning.

2.3 Traditional vs. distance education

Education is defined as *"systematic guiding of the learning process that is directed at the conscious and perfect learning"* (Engeström 1988). Also, education is *"a process of teaching, training and learning, especially in schools or colleges, to improve knowledge and develop skills"* (Oxford Advanced Learner's Dictionary 2005). Synonyms of education are, e.g., instruction, teaching, training, and breeding. The most important goal of education should be to support and promote learning. To be able to support the learning process, the quality of teaching must be high (e.g., Engeström 1988).

Furthermore, **distance education** has been defined in various ways, but one of the most extensive definitions is the one that Oregon Network for Education (2005) uses. According to them, distance education is *"education that takes place when the instructor and student are separated by space and/or time. The gap between the two can be bridged through the use of technology - such as audio tapes, videoconferencing, satellite broadcasts and online technology - and/or more traditional delivery methods, such as the postal service"* (Oregon Network for Education 2005).

In research traditional classroom learning has been compared to online learning with findings that there is "no significant difference" in learning effectiveness (e.g., Russell, 2001). Joy & Garcia (2000) criticize this research which assumes that delivery media alone influences the learning outcome. According to Joy & Garcia (2000), *"learning effectiveness is a function of effective pedagogical practices"*. So, the basic goals of distance education are the same as in traditional classroom education, but the ways of learning and teaching as well as the format of the content are different.

2.3.1 Educational goals, contents, and methods

According to Engeström (1988), there are three important elements in education: *educational goals*, *educational content* and *educational methods*. All of these include both external and internal factors. External factors consist of resorts that are used for controlling observable behavior of students and learning about the situation itself, and the internal factors consist of resorts that are used for guiding the mental process of students. By concentrating only on the external factors education becomes fragmental and the learning results are not as good. Of course, external factors are also important, but by using internal factors it is possible to attain better learning results (Engeström 1988).

Engeström's (1988) perfect learning process (see Section 2.2.3) and its internal factors can also be adopted into the virtual learning environment context. **Educational goals** are at least as important in online learning as in the traditional classroom environment, if not even more important because students are expected to be more self-directed (see Section 2.2.6), and the learning environment should be prepared to tackle new issues and concerns, and to develop new approaches, as well as, new skills in order to create an empowering learning process (Palloff & Pratt 2001). Moreover, like Palloff and Pratt (2001) argue further, *"when teaching and learning leave the classroom, it is up to the instructor to create a container within which the course proceeds by posting goals, objectives, and the expected outcome for the course, initial guidelines for participation, thoughts and questions to kick off discussions, and assessments to be completed collaboratively"*.

In the virtual learning environment **educational content** is mostly in digital form and students are easily able to find more learning materials from the Internet (presuming that students have the required skills for the acquisition of information). Content is easier to divide into must-know and should-know topics and extend with nice-to-know topics because of hypertext (Karjalainen & Jaakkola 1999). Hypertext (as well as simulations, animations and videos) also enables the use of authentic and applied exercises.

Educational methods can also be divided into external and internal factors. External methods include *forms of education* that can be immediately seen (who is communicating with whom, and who is active) and *forms of interaction* (how students are interacting; size of groups), and internal factors include *educational tasks* (function of the teaching). Educational tasks can be divided into eight categories (Engeström 1988):

- **Preparing for the new and motivating:** explaining the meaning of new topics and its' connections to previous knowledge; arousing of motivation and channeling that into a subject under discussion; rising of informational conflict with learning assignments
- **Orientation:** identification of learning goals and orientation base
- **Delivery of new information:** fulfilling the orientation base and enriching it with modifications, details and footnotes using various forms of teaching; reorganization and interpretation of knowledge; active discovery of new information based on orientation base
- **Bone up on learned topic:** re-examining the learned topic before entering into a new topic
- **Systematization:** clarifying analysis of learnt topic; learning to separate essential knowledge from unessential, to recognize unclear issues, and to become aware of mutual connections and relationships between learnt issues
- **Rehearse:** transformation of information to knowledge or competent; requires repeated rehearsing
- **Appliance:** solving new learning assignments based on learned knowledge

- **Control:** assessment of validity and usability of learnt topic as well as a new mental model; critical examination of learnt knowledge based on authentic assignments; self-evaluation

It seems that these educational methods will change the most when we move from the traditional classroom into the virtual learning environment. Moreover, because there is a need for different interaction methods to be employed, changes in the interpersonal relationships between the teacher and students are also needed (Bower 2001). According to Palloff and Pratt (2001), collaboration in learning results from interactions among students themselves and interactions between teacher and students. It is the relationships and interactions among people through which knowledge is primarily generated. Moreover, learning in the virtual learning environment cannot be passive; learning is an active process in which both the teacher and the student must take a part.

The whole learning process can be based on some specific learning or teaching theory (see Section 2.2.5), but the selection of the used learning or teaching method should always be based on the objective evaluation that is the best or most suitable choice in that particular learning situation (Manninen & Pesonen 2001).

2.3.2 Educational methods in virtual learning environment

It is important to realize that different didactical and pedagogical approaches fit into different learning situations and needs. Different learning theories (the three most important trends have been introduced in Section 2.2.5) represent different kinds of characters for learning. Each theory emphasizes different features of human learning.

There are many suitable approaches and models for teaching and learning in virtual learning environments. Some of these are briefly introduced in alphabetical order as follows:

- **Active learning:** students must *"read, write, discuss, or be engaged in solving problems … engage in such higher-order thinking tasks as analysis, synthesis, and evaluation … instructional activities involving students in doing things and thinking about what they are doing"* (Bonwell & Eison 1991)
- **Anchored learning:** learning where *"activities are designed around a realistic situation - or anchor - in which there is a problem to be solved by the group … encourages students to view knowledge as tools to be applied to new situations, rather than knowledge as facts to be learnt"* (Floodman 2004)
- **Cognitive apprenticeship:** learning through guided experience where *"experts are present to coach and model the cognitive activity"* (Barab & Duffy 2000). Knowledge is learnt by solving problems and carrying out tasks in an anchored context (Collins et al. 1989)
- **Cognitive learning:** focus on complete learning; processing new information and connecting it into existing data structures (Manninen & Pesonen 2001)

- **Collaborative learning**, cooperative learning or peer learning: learners working in groups or in pairs on the same task simultaneously, searching for understanding, meaning or solution, interacting to learn; students work in groups to maximize the learning of all individuals in the group (e.g., McKeachie 1999)
- **Constructivism:** focus on construction of knowledge; commitment to learning, independence, situational and contextual involvement, peaking of activity (Manninen & Pesonen 2001)
- **Critical humanism:** focus on consciousness; awareness of characteristic values, attitudes and types of action (Manninen & Pesonen 2001)
- **Discovery learning:** teaching method in which information or evidence is presented to students in a way which enables them to progress to new levels of understanding; students learn well when they discover what is to be learned for themselves (e.g., Baldwin 1996)
- **Experiential learning:** learning process of acquiring skills, knowledge and understanding through experience rather than through formal education or training (e.g., McKeachie 1999)
- **Humanistic learning:** focus on self-improvement; problem-centered, self-directed, highlight on students own responsibility (Manninen & Pesonen 2001)
- **Instructional learning:** focus on teaching and motivation; teacher-centered, predetermined goals, content, teaching and assessment methods; response to impulses, receiving of knowledge (Manninen & Pesonen 2001)
- **Learning through design:** learning occurs while designing some artifact such as games, textile patterns, robots, and interactive devices; design activities can provide personally meaningful contexts for learning (e.g., Haury 2002)
- **Reciprocal teaching:** a teaching strategy in which "students are involved in summarizing, question-generating, clarifying, and predicting as they read texts and observe phenomena...[and] both teacher and students share the responsibility for the conduct of the discussion" (e.g., Palincsar & Brown 1984; Palincsar 1986)
- **Problem-based learning:** a widely used inquiry technique that involves having students taught by solving real-world problems through a series of steps, while working in groups (e.g., McKeachie 1999)

As in teaching in general, there is not just one unified way to teach computer science and new technologies enable new kinds of educational methods and new ways to utilize these (Manninen & Pesonen, 2001). However, because of the "nature" of the subject, doing and learning by doing are the main roles. While teaching computer science few approaches are used more than others, e.g., constructivistic methods such as active learning (McConnell, J. 1996), learning by doing (e.g., Reid & Wilson 2005), discovery learning (e.g., Baldwin 1996), peer learning (e.g., Wills et al. 1994), or collaborative learning (e.g., Rodger

1995). Furthermore, learning is usually situated in authentic learning environments (e.g., Herrmann & Popyack 1995).

2.4 Changing role of the teacher

While moving from the traditional classroom into the web, the teacher's role is definitely no longer just to deliver information; it becomes more of a facilitator than a traditional lecturer (Yang & Cornelious 2005). The teacher is now helping students to deal with new information and the management of knowledge; a teacher selects and filters the information for the student's consideration, provides thought-provoking questions, and facilitates the well-considered discussion (Kettner-Polley 1999). Responsibility for learning is transferred from teacher to student, but the teacher's role as an instructor is remarkable; the teacher serves as facilitator while students develop their personal understanding of course content by collaborating with each other (Yang & Cornelious 2005).

Besides being a facilitator, the teacher should be an instructional designer (Zheng & Smaldino 2003). *"It is also important for the teacher to motivate students to adjust their role when becoming an online learner"* (Yang & Cornelious 2005). The teacher plays an important role in motivating effective online discussions as well (Wu & Hiltz 2004). Tella et al. (2001) conclude the role of the teacher by listing five key roles on the Web as follows:

- **Motivator:** keeps students' motivation and activity at a high level by focusing attention on students, by offering proper learning materials, and by maintaining collaboration and co-operation. The teacher is asking, demanding, inspiring and persuades students to participate. The teacher speaks out and responds to students' activities, pays attention to the students, creates learning opportunities, and motivates students by his or her own actions. Also in web-based learning personalized feedback is very essential.
- **Networker:** establishes networked relations to different experts and specialists and offers these resources also for students use.
- **Organizer:** organizes teaching and learning environments that drive students into collaborative learning by making choices between different tools, applications and media. The teacher organizes structures and sets the rhythm for the course, sets goals, conducts the course based on a flexible study plan, makes stimulating questions, and comments and guides the discussion.
- **Signaler:** creates nets of communication, informs and guides students during the learning process by making specific instructions and guiding questions on the web. The teacher creates the rules for communication and ensures that all students will understand them.

- **Instructor or tutor:** makes it possible for students to learn better, but without controlling too much. The teacher helps students to understand, guides them towards active learning, and enables the process where the student internalizes the external knowledge and transforms it into his or her own knowledge.

According to Tella et al. (2001), there are also other roles for teachers, such as assessor, supporter, expert or storyteller. However, the teacher needs the same kind of didactical and pedagogical skills as in the traditional classroom, but the form of teaching and the teaching environment is changing. Furthermore, teachers as well as students need new computing and communication skills.

Teachers need to create deep and durable learning in the virtual learning environment. Hacker & Niederhauser (2000) offers five principles to help teachers to accomplish this goal:

1. **Active participation in learning** by changing the student's role from passive recipients of knowledge to active constructors of their own knowledge. It is the teacher's job to promote this change. Learners become meaningful makers who actively select, organize, and integrate their experiences with existing knowledge. Students are required to construct deep explanations, justifications, and reasons for what they think and do.
2. **Effective use of examples** because it has been shown that case-based instruction suits computer-based technology. By using examples that are anchored in contextualized and authentic cases, we can improve educational outcomes.
3. **Collaborative problem solving** that can increase specific problem-solving abilities and general metacognitive understanding of how, when, and why to use problem solving strategies.
4. **Effective use of feedback** means that feedback is commensurate with performance - too much feedback may prevent students from learning how to regulate their performance on their own.
5. **Motivational components** that enhance self-efficacy and perceived challenges. All four previous principles of instruction will also enhance the motivation to learn.

As a conclusion, it is important for the teacher to master and design delivery strategies, techniques as well as methods for teaching online courses (Yang & Cornelious 2005).

2.5 Assessment of student learning outcomes

Educational assessment is difficult to define (Payne 1974). Educational literature is full of different kinds of definitions of assessment and during the past few decades the area of achievement assessment has been undergoing major changes. Since the mid 1980's the assessment literature has been enriched with many new terms, e.g., such as *performance assessment*, *authentic assessment*, *direct assessment*, *constructive assessment*, *incidental assessment*, *informal assessment*, *balanced assessment*, *curriculum-embedded assessment*, and *curriculum-based assessment* (Birenbaum 1996). However, one important question rises above all: what, how and why the need to assess?

Assessment is a fundamental part of any curriculum (Frye 1999; Korpinen 1982); it is a part of all phases of learning. The same assessment learning cycle, shown in Figure 3, takes place at all educational levels starting from student level all the way to university level. Assessment is the first step in this continual cycle which includes measurement, feedback, reflection, and change (Frye 1999). Moreover, it helps students and teachers to see how learning improves during the learning process. Assessment is often divided into three steps: **diagnostic assessment**, **formative assessment**, and **summative assessment** (Bloom et al. 1971). Every step gives us different kinds of information that can be used in different phases of the learning process (Korpinen 1982). Diagnostic assessment concentrates on student's qualifications, formative assessment on the learning process, and summative assessment on the learning outcome (Korpinen 1982). *"Learning outcomes … encompass a wide range of student attributes and abilities, both cognitive and affective, which are a measure of how their college experiences have supported their development as individuals"* (Frye 1999). According to Frye (1999), a **cognitive outcome** includes *"demonstrable acquisition of specific knowledge and skills"*; what do students know that they didn't know before, and what can they do that they couldn't do before. An **affective outcome** is related to attitudes, values, and beliefs that influence behavior, and those can not be directly measured (Frye 1999). Assessment can be summarized as in Figure 4.

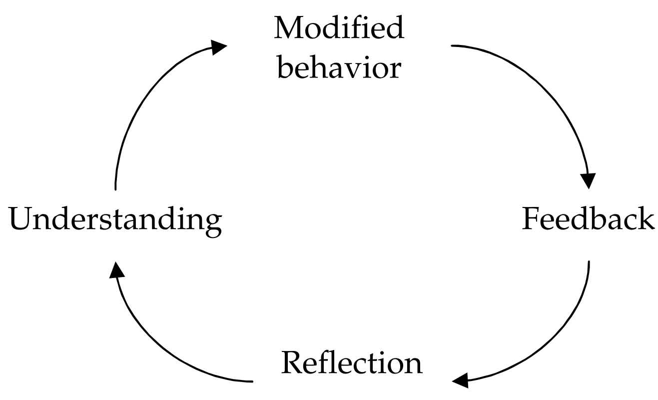

FIGURE 3 Assessment learning cycle (Frye 1999)

Assessment is not just the measurement of learning, and the purpose of assessment is not merely to gather information. Assessment is seen as a vehicle of improvement. Analysis of the learning outcome enables rationalization of learning (helps the student to learn) as well as the development of education (helps teacher to instruct) (Frye 1999; Koppinen et al. 1999; Wiggins 1997). Frequent assessment of a student helps to refine the concepts and deepen their understanding; it also conveys high expectations, which further stimulate learning (Dempster 1991).

Assessment includes two important processes: 1) **measurement**, which includes gathering evidence or important information related to assessment, and 2) **evaluation**, which refers to the decisions made on the basis of the measurement (Kauchak and Eggen 1998). An effective teacher gathers information from different sources, including conventional tests, homework, involvement on the class or Web, and authentic assessment, such as mind maps made during a brainstorm session, or crib sheets made for the final exam as an assignment (Kauchak and Eggen 1998).

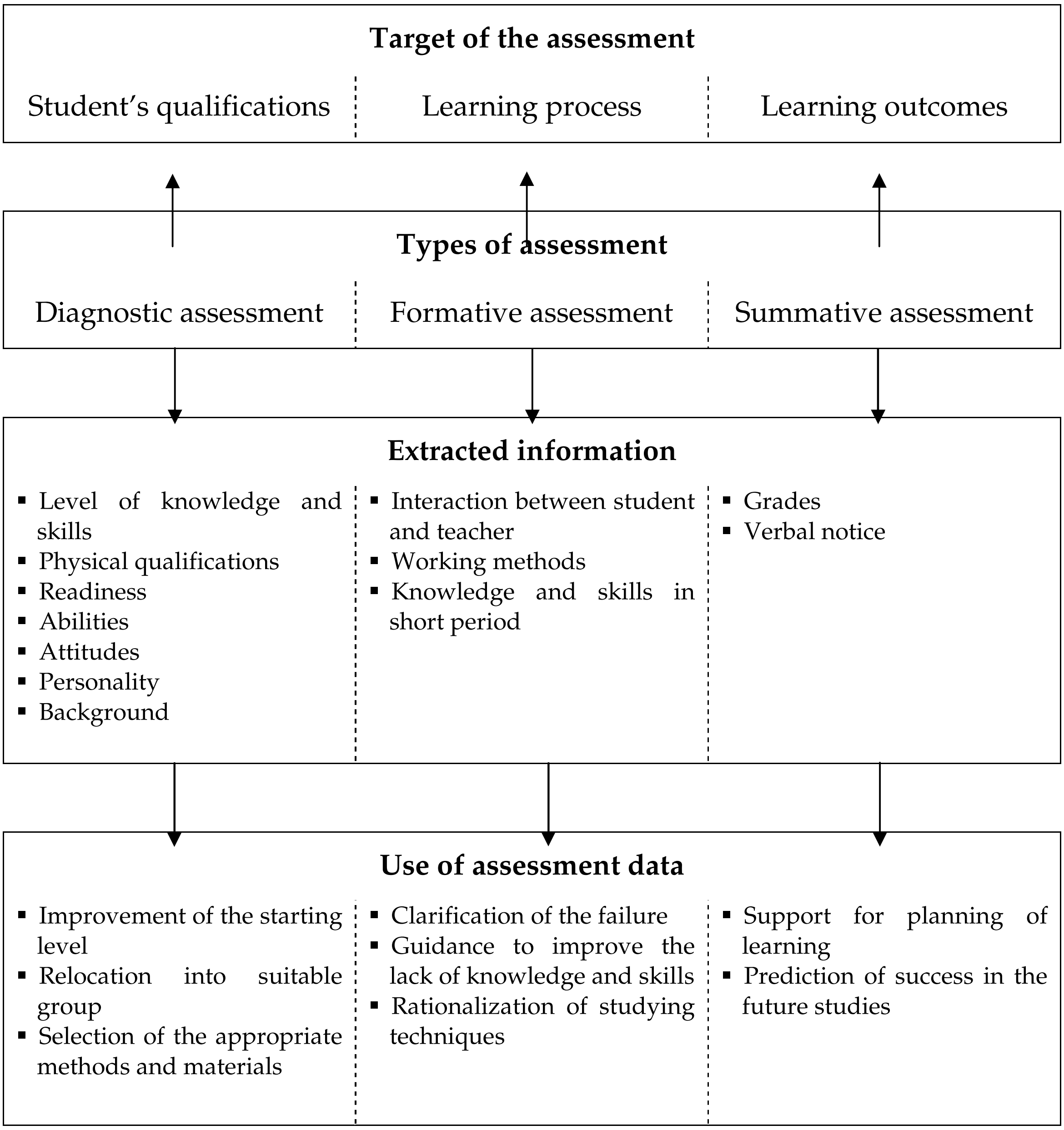

FIGURE 4 Assessment as a whole (Korpinen 1976)

Traditionally a final teacher-made exam or standardized test has been the most used assessment method during higher education courses, although many have argued that it is not the best way to assess the learning outcome. For example Wiggins (1997) says that *"conventional tests often prevent students from fully understanding and meeting their intellectual obligations"*. Moreover, Kauchak and Eggen (1998) list the following reasons: traditional testing focuses on knowledge and recall of information, it provides little insight into the way learners think, and it does not assess a students' ability to apply their understanding to real world problems. In the virtual learning environment implementation of the traditional final exam is more difficult, e.g., you can not be sure who is taking an exam on the Web (Yang & Cornelious 2005). During the past few decades teachers and researchers have been developing new, more authentic and alternative ways to assess.

2.5.1 Authentic assessment

Authentic assessment directly measures a student's performance through "real life" tasks (Worthen 1993) such as writing a letter or an editorial commentary for the school newspaper, designing a lab activity for science students, or solving some real-life problem (e.g., Kauchak and Eggen 1998). We could continue to list the examples with the students' own custom-made software projects, and writing a term paper that would be self-evaluated as well as peer evaluated (both of these are used at the Department of Mathematical Information Technology, University of Jyväskylä).

There are different forms of authentic assessment. Next we take a closer look at two of them: *performance assessment* and *portfolios*. Both of these can easily be adapted into online learning as well.

2.5.2 Performance assessment

According to Kauchak and Eggen (1998), performance assessment measures skills and understanding by directly measuring a student's performance in a natural setting. *Systematic observation*, *checklists*, and *rating scales* are used as evaluation methods.

Systematic observation is based upon a teacher taking notes that describe a learner's performance based on preset evaluation criteria. **Checklists** are written descriptions of characteristics that must be present in an acceptable performance. Use of checklists extends systematic observation. **Rating scales** are written descriptions of characteristics and scales of values on which each characteristic is rated. (Kauchak and Eggen 1998)

In online learning performance assessment could include, assessment of, e.g., online discussions, different kinds of learning assignments, and questionnaires.

2.5.3 Portfolio assessment

Portfolios are collections of work that are reviewed against preset evaluation criteria. Portfolios could include products like essays, journal entries, video clips, photos, discussions, tapes of presentations, term papers, and designed materials. Portfolios should reflect the learning process; products made at different times indicate changes that occur during the passed time. (Kauchak and Eggen 1998; Wolf 1988)

When using portfolios students should be involved in deciding the evaluating criteria or at least to have been told in advance how the work will be evaluated. Based on these criteria students decide what they want to include in this so-called *sample portfolio* which is then evaluated (Kauchak and Eggen 1998; Tenhula et al. 1996).

In online learning portfolio assessment is quite easy to execute, because all products are in digital format (if they have been saved, e.g. chat discussions). A portfolio could include, e.g., online discussions on a discussion board or in chat, learning assignments, learning diaries, self-evaluations, peer evaluations, opponent reviews, and term papers.

2.5.4 Portfolios in the assessment of experiential learning

During experiential learning new knowledge and new skills are acquired through experiencing new issues in real-life situations (see Section 2.3.2). Portfolio assessment helps to recognize this kind of learning, to identify competences that students have developed during the learning sessions, and to assemble evidence of these competences (Henebery et al. 1987; Kauchak and Eggen 1998).

Henebery et al. (1987) has developed a process model for assessing the experiential learning. The model utilizes portfolios as an assessment tool to assess *prior to learning* (knowledge that students have when they start the course) and *sponsored learning* (learning that results from planned experiences built into a course). This process model and its nine steps are briefly described in Figure 5. It starts by identifying the experiences where learning took place, and what has been learnt from them. A tutor or teacher will help students to identify learning experiences from their wider life experiences.

Stage three involves forming competence statements. The term **competence** is defined as *"a blend of skills, knowledge, aptitudes and attitudes which can be successfully applied, e.g. to complete a task or to achieve a demonstrable outcome"* (Henebery et al. 1987). At first, students will identify what specific items, skills or areas of knowledge were involved in learning situations in the past, and then they will generalize these experiences in terms which might be more applicable to future situations. This leads students *"to indicate the extent to which acquired learning might be transferable in another context"* (Henebery et al. 1987).

1. Reflecting on experience
- Individual or group work involving writing and discussing life experiences
- Writing accounts of experience
- Developing study and communication skills

2. Identifying actual learning
- Analyzing experiences for skills or knowledge
- Building self-confidence
- Developing self-assessment skills

3. Forming competence statements
- Identifying general competences based on skills or knowledge acquired

4. Developing career or educational plan

5. Matching competence statements to career or educational plan
- Matching statements of competence to intended use
- Defining competences as accurately and precisely as possible
- Relating statements to career or educational plan

6. Assembling evidence and organizing assessment of learning
- Obtaining certificates, records, photographs, plans, etc.
- Devising performance assessments e.g., in class and in realistic work situations
- Gathering evidence from a range sources
- Relating evidence to competence statements

7. Organizing final presentation of portfolio
- Organizing evidence to suit intended purpose, e.g. to match course entry, job specification requirements
- Assembling portfolio to include C.V., table of contents, profile statement of competences and suitability categorized evidence

8. Presenting portfolio for evaluation
- By admissions tutor, selector or employer

9. Further student support

FIGURE 5 Assessment process of experiential learning; modified from Henebery et al. (1987)

While defining the competences during the first three stages, students should next develop a realistic career or educational plan and determine realistic future goals (e.g., possible next courses or jobs) in stage four. In stage five students establish a purpose for their portfolios, and identify a range of competences or qualities as well as begin to develop and obtain evidence of such competences or qualities.

During stage six students gain evidence of learning from experiences through assessment. The role of the tutor or teacher is to *"provide the student with suggestions and guidance in how to obtain the most useful evidence from outside sources"* (e.g., product assessment including photographs, plans, drawings, and products of vocational skills or hobbies), and to organize situations and assessments during the course providing the opportunities for on-course assessment (e.g., written assessments, oral interviews, simulations and role-play, performance testing, examinations and tests, and situational observations). (Henebery et al. 1987)

Stage seven includes preparation of the student's portfolio for its intended purpose. The portfolio should consist of an introduction written by the student, a table of contents or reader's guide, curriculum vitae and references, a profile consisting of a list of competence statements, and sections of the portfolio where evidence is to be found in the form of positive assessments and supporting documentation. (Henebery et al. 1987)

During stage eight portfolios are prepared for presentation by the terms of entry criteria (who is able to see and what). In the last, ninth stage, this presented model includes further student support that means some form of long-term support and guidance beyond the end of the course.

This model can also be easily adapted into virtual learning. Good examples of applications are learning craftsmanship (Käspaikka 2005) and computing online. In both of these examples learning is based on learning-by-doing or experiential learning (see Section 2.3.2) where students might have some prior knowledge, and an off-shoot of learning is some sort of concrete and appreciable product (evidence of learnt competence, e.g., handwork, document or software). In both of these cases learning can be assessed with portfolios. This model (Figure 5) can also be modified so that experience is part of the course; theory is learnt on the course and experience is increased in assignments where theory is adapted into practice.

2.6 Summary of pedagogical background

Most of the learners and educators have a long educational history in the classroom environment and it might be hard to suddenly move into the virtual learning environment because learning and teaching changes. New requirements (see Section 2.2.6) for a learner have been set and the recognition of one's own individual learning style becomes even more essential (see Section 2.1). Learners should have more internal motivation, and they need to be more initiative, independent, creative and reflective (see Section 2.2.6). Teachers are no longer physically present (see Sections 2.2.6 & 2.4) and most of the interaction happens through written text without seeing, hearing or touching people with whom the learners are communicating (see Section 2.2.6).

The role of the teacher transforms when the responsibility for learning transfers from teacher to student. Learning becomes more learner-centered, but the role of the teacher as an instructor is still essential (See Sections 2.4). New technology opens new kinds of possibilities to utilize different educational methods (see Section 2.3.2). Assessment of the learning outcome is also changing; traditionally, final exams are much harder to execute online, so we need new, more authentic assessment methods (see Section 2.5.1).

3 EXISTING DESIGN PROCESSES AND MODELS

A general **process** definition for software development usually consists of three elements: *phases*, *activities*, and *tasks* (ISO/IEC 15504-1:2004; ISO/IEC 12207:1995). A **phase** represents the highest level of abstraction. Each phase contains a logically grouped set of activities and tasks that perform a process development function. Each phase must be passed in order to realize the entire process.

Each phase can be divided into **activities** that are composed of tasks. Activities can overlap one another when tasks are related to each other by a certain function or certain participator.

A **task** represents a particular set of steps that occur within an activity. It is the lower level unit of the whole process with detailed information for completing the activity itself. Some tasks are performed only once during the entire projects lifetime and others are performed for each iteration release. Typical task descriptions include:

- Management responsibilities and other roles; who is doing what and when
- A brief explanation regarding why each task is performed
- Possible references that describe the required processes to be performed or the documentation to be produced
- Input (possible documents, data, or other products) that is required for or used during this task, or standards that must be adhered to when completing the task
- Procedures or steps that must be performed within a task

- Output (documents, data or other products) that is produced during the task

Many benefits of the utilization of well-defined development methods have been established. For example, Smolander et al. (1990) list their findings concerning information systems design methods as follows:

- Enhanced standardization of documentation and system work
- Makes system development easier and faster
- Ensures better application quality
- Structures system work and makes project management easier
- Improves maintainability of applications
- Yields less dependency on key persons
- Allows for easier construction of large databases
- Makes testing easier
- Allows easier detection of naming problems

Jacobson et al. (1999: xviii) describe a **software engineering process** as *"who is doing what when and how to reach a certain goal … an effective process provides guidelines for the effective development of quality software. It captures and presents the best practices that the current state of the art permits"*. Moreover, the process guides all the participants involved and leads to more stable development steps.

The proposed web course design methodology follows a Unified Process and adapts metaphors from the software design process that is why the Unified Process is briefly reviewed in section 3.1. The Unified Process can be joined with the instructional design (see section 3.2) to ensure that all general principles of learning and instruction are considered during the design process; while designing educational environment processes must also include pedagogical design.

Recently White (2000) and Montilva (2000) described development processes for web course design and we briefly review these two approaches in sections 3.3 & 3.4. Baloian et al. (2001) described a model for component-based courseware development that is briefly reviewed in section 3.5.

3.1 The Unified Process

Building a web course is similar to the design and implementation of a software application. Hence, the terms related to software processes that form the basis of software development, such as a concept phase (feasibility study), analysis, architecture, design and implementation, testing, iterative and incremental can also serve as a well-established conceptual framework for web course design. This has also been the starting point of the approaches that will be reviewed in Sections 3.3-3.5. Due to the fact that the initial stages of the presented web course development method mimics the Unified Process (UP), and next this thesis shortly reviews this approach (with some direct quotations) based on Jacobson et al. (1999).

The **Unified Software Development Process** is, like all other process models, a development process where a set of activities is needed to transform the user's requirements into a software system are presented (see Figure 6). The Unified Process is use-case driven, architecture-centric, iterative, and incremental. The goal of the whole process is *"to guide developers in efficiently implementing and deploying systems that meet customers' needs"* (Jacobson et al. 1999).

FIGURE 6 A software development process by Jacobson et al. (1999)

Software systems should be designed to serve their users, so we must know what the prospective users want and need. The user could be a human or another system that interacts with our system. In response to the user's actions the system performs a sequence of actions that leads to a response. Jacobson et al. (1999) describes this sort of interaction as a **use-case**, *"a piece of functionality that gives a user a result of value"*. Moreover, *"all the use-cases together makes up the use-case model which describes the complete functionality of the system"* by capturing all functional requirements.

The use-case model answers the question: What is the system supposed to do? We should think about the value of the functions to users, and not just speculate as to what functions might be desirable. With use-cases we can find the true requirements and represent them in a suitable way for users, customers, and developers. Use-cases are not just tools to capture all the requirements of a system. They also drive its design, implementation, and test when developers create design and implementation models that realize the use-cases.

The Unified Process is use-case driven, but the system architecture (i.e., general structure of software) establishes the skeleton for technical design. The architecture is illustrated using different views of the system being built; it is a view of the whole design with the important characteristics made more visible by leaving details aside. This *"process helps the architect to focus on the right goals, such as understandability, resilience to future changes, and reuse"* (Jacobson et al. 1999).

Usually software projects are large and continue over several months or a year or even more. This is one reason why projects are usually divided into smaller mini-projects: *"each mini-project is an iteration that results in an increment. Iterations refer to steps in the workflow, and an increment, to growth in the product"* (Jacobson et al. 1999). According to Jacobson et al. (1999), the selection of what is to be implemented during the current iteration is usually based on two factors:

- The iteration deals with a group of use-cases that together extend the usability of the product as developed so far.
- The iteration deals with the most important risks.

According to Jacobson et al. (1999), *"in every iteration, the developers identify and specify the relevant use-cases; create a design of the chosen architecture as a guide, implement the design in components, and verify that the components satisfy the use-cases. If an iteration meets its goals … developers proceed with the next iteration. When an iteration does not meet its goals, the developers must revisit their previous decisions and try a new approach."*

3.2 Instructional design

Instructional Design can be defined as the systematic process of translating general principles of learning and instruction into plans for instructional materials and learning. Much of the foundation of the field of instructional design was laid by Robert M. Gagné and his research at Florida State University (e.g., Gagné et al. 1988). His identification of the "Nine Events of Instruction" developed in the 1970s influences theory and practice in the field today.

In instructional design one systematically develops instructional specifications using learning and instructional theory to ensure the quality of instruction. The instructional development process includes analysis of the learning needs and goals, and the development of a delivery system to meet those needs. It also includes the development of instructional materials and activities; not forgetting to try out and evaluate all instruction and learner activities.

Instructional design is the systematic approach to analyze, design, develop, implement, and evaluate learning materials and activities, based on the needs of the learner and content requirements. As being more learner-centered rather than the traditional teacher-centered approach to instruction, the instructional design is essential especially in e-learning.

The **ADDIE Model**, which stands for Analysis, Design, Development, Implementation, and Evaluation, represents one of the basic models of Instructional Design that can be used to develop web courses (Anglada 2002; Peterson 2003). The ADDIE model is an iterative Instructional Design process (see Figure 7), where the results of the formative evaluation of each phase may lead the instructional designer back to any previous phase.

The whole process starts with an **Analysis** phase where one should first define the learning goals (or needs) and objectives for the course. Secondly, one should consider the age of learners', cultural backgrounds, past experiences, interests and educational levels to better understand learners and their needs. Thirdly, the timeline and resources for the development project have to be settled. Finally last but not least, one should also determine the overall content and evaluation strategies for the course during this phase.

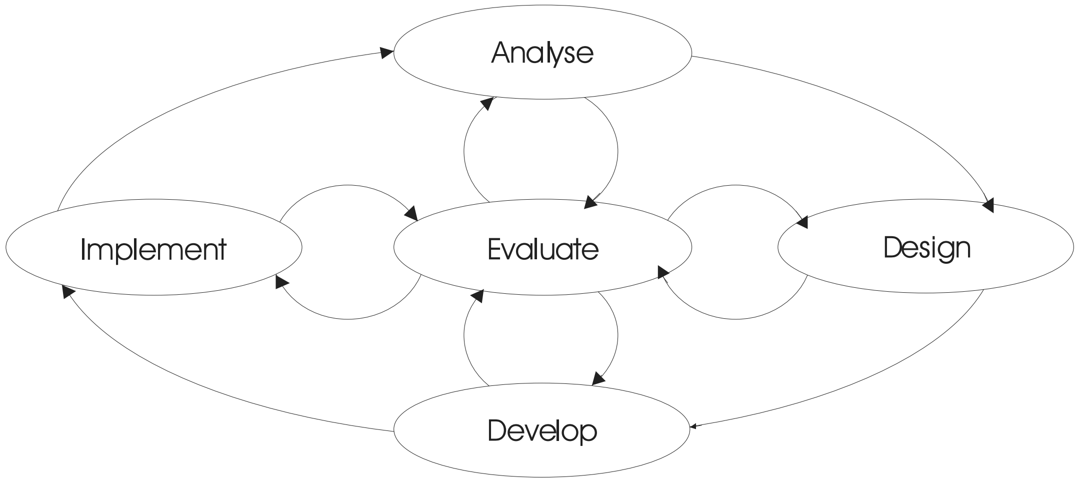

FIGURE 7 Life circle of ADDIE Model by Anglada (2002)

The second phase, **Design**, is concerned with the actual content. During this phase one should design the user interface, determine user objectives, develop content outline, storyboard the course, make media selections, and produce any materials required for instruction in the given subject matter. In some cases it is good to create a prototype for quick testing. By evaluating the prototype designers will get precious information for further development of the course.

The actual creation of the web course takes place in the third phase called the **Development** phase. During this phase one should construct and develop the content, script and program functional elements, create graphics and animation sequences, and create supplement learning guides.

The fourth phase is the **Implementation** phase. The purpose of this phase is the effective and efficient delivery of instruction – putting the plan into action. The implementation requires identification of the elements of the learning environment and development of teaching strategies. Implementation should be based in a pedagogical theory that guides the delivery of the material - the ones used in the development of the content.

In many cases it might be helpful to demo the web course first with a small group of students so that their feedback can be used to revise and improve the web course before full-scale implementation. The Implementation phase also includes course orientation, syllabus adjustment, and scheduling of synchronous elements.

Evaluation of the experience is the last phase of the ADDIE Model. It provides information that should be used during the later iterations. The best way to carry out the evaluation is to use an independent evaluator who makes notes and details issues for resolution.

Evaluation can be both formative and summative. Formative evaluation impacts the process as it is happening while summative evaluation will be done at the completion of the process. Both forms of evaluation are helpful in this model.

3.3 A Web Course Development Process

White (2000) describes the web course development process used at the University of Houston Clear Lake (UHCL) for creating selected courses in software engineering. The process is divided into three con-current sub-processes: *Standards and Policy Creation*, *Course Material Creation*, and *Web-Site/Web-Page Creation*. These sub-processes can be treated separately, but this requires a more evolutionary style of development. In each sub-process, key process players (actors) and major results/documents that must be produced have been introduced. White's model reminds one of **a modified waterfall model** for software development (e.g., McConnell, S. 1996).

In *Standards and Policy Creation* sub-processes, needed regulations and constraints for different academic actors are created. The other two sub-processes proceed concurrently with each other, resulting in the final web-based course. White (2000) discusses this concurrence with in use of WebCT: *"If one is to use such a tool one must begin the web design at the same time as course material design in order to work most efficiently and productively (that is, to avoid re-design and re-implementation of possible major portions of the course)"*.

White uses software engineering metaphors when she describes the major activities of the web course development process. In some stages (see Figure 8), there is more than one concurrent activity occurring during the same stage. Also, exact documentation during all stages is applied according to the general practices in software engineering processes.

Next the actual activities within the development steps are briefly described. During the first stage, all risks and benefits that the online course might produce are analyzed by the Dean and faculty. Next, all the needed resources (hardware, software and people support) are considered, once the courses to be provided are selected.

In the second stage, courses are assigned content experts to develop the course materials, and to form the development teams. A schedule for development of the courses is also planned. The third stage is the actual design phase, and includes the creation of the course syllabus, course policy, course objectives and content design. Content design is restricted to weekly unit overviews (topic of the week, objectives and major assessments). The web developer designs the top-level web structure of the course based on design documents produced by the content expert and instructional designer. This structure contains material and communication mechanisms (e.g., chat rooms and bulletin boards) as part of the initial website design.

During the fourth stage the actual course content is created and finalized. All assignments, student guides, support materials, etc. must be created and converted into an appropriate format (html, PDF, etc.). Fifth, a testing stage follows after the course has been fully developed and becomes available online. During testing, students answer questions about the materials provided, conducting some assessments and examinations attempting to determine the overall success of the course, including its strengths and weaknesses. According to

White (2000), *"the idea of the test is to determine the weak points and correct them before offering the course at large"*. Later, web courses will require maintenance support on the website. This last stage was still under discussion at the UHCL.

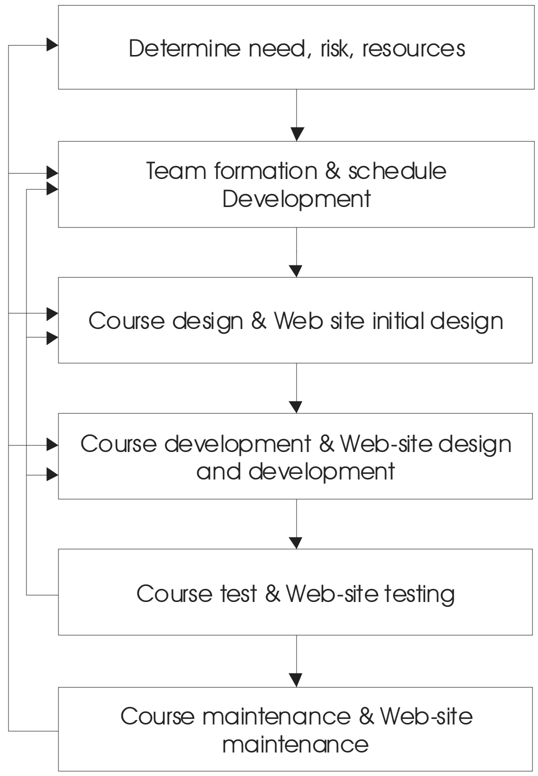

FIGURE 8 Major activities of the web course development process by White (2000)

By the autumn/fall 2000, this process was used for design, development and testing of three strictly web-based software engineering courses. Newer information was not available on the UHCL website (see http://sce.cl.uh.edu/swen/index.htm).

3.4 A Software Engineering Approach

Montilva (2000) describes *"a method that applies object-oriented software engineering to the process of developing web-based courses"*. Moreover, Montilva (2000) describes the phases, steps, activities, and techniques as follows:

- **Analyze** and specify the technical and instructional requirements of a course
- **Design** the structure, interface, content, and interaction of the course
- **Produce** the content, user interface and media required by the course
- **Deliver** the web-based course to its users

Montilva's six-phase method (Figure 9) has been used to develop web-based study guides for distance education. The method begins with an analysis of the web course domain and iterates over the entire development cycle ending with its delivery. The evaluation phase (verification & validation) has a central role, meaning that the evaluation of results begins in the first phase, instead of being executed at the end. This model reminds **the Star Model** of Preece et al. (1994) for human-centered software development.

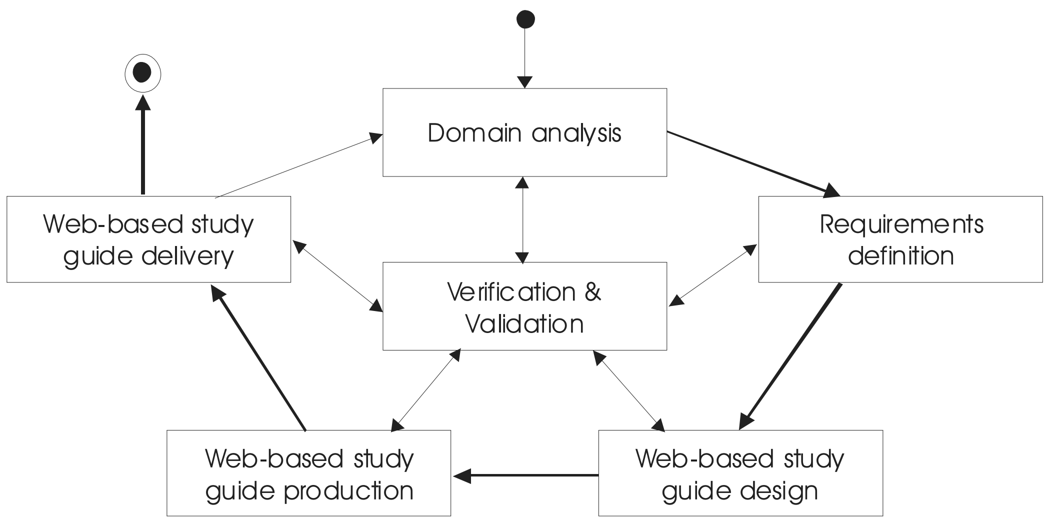

FIGURE 9 The phases of the method by Montilva (2000)

During the first phase an analysis of the web course domain is performed including:

- Identification and analysis of the subject of the course, organization of the content in themes, and definition of the objectives and goals of the course
- Assessment of the student's prior knowledge on the subject, skills required before taking the course, motivation, and abilities needed to achieve computer proficiency, to follow a distance learning course and to conduct independent study
- Analyzing the instructor's abilities: subject-matter knowledge, distance teaching experience and attitude, computer proficiency, knowledge and experience on the Internet services (WWW, FTP, E-Mail, News, etc.), and pedagogical profile
- The learning environment: location of the students, telecommunication technology and hardware-software platform, the social and physical environment, and time availability for completing the course.

In the second phase, all requirements that should be satisfied by the final course are defined and specified. Through requirements definition the development team considers the most important features during the design phase, and verifies and validates the study guide once it has been designed and produced. The requirements include:

- Learning activities that students should perform (reading, writing, viewing, listening, group interaction, testing, etc.), and the length of the course in weeks and number of study hours in order to produce a timetable for the course
- Interaction requirements: types of interaction to be supported and other media to be used together with the Web study guide
- Development and operational resources: time, hardware, software, people and financial support, to estimate the time and cost of developing a Web study guide
- Quality attributes including structural attributes (modularity, visibility, balance, modifiability, navigation), interface attributes (organization and visualization of hyperlinks and multimedia items by page length, background color and texture, design grids, size and resolution of graphics and images, and typographic design), and content attributes (the scope of the content, the logical sequence and organization of the content, its completeness, the way of stimulating or motivating the student, the feedback on assignments, the method used for evaluation of the content and the repetition and summary of the most important ideas), to achieve well established Web style rules and design criteria

The third phase includes the design of the web study guide, focusing on the different aspects of design such as structural, navigational, conceptual, and sensorial aspects. This proceeds in the following order:

- Design of the basic structure: main page, units, lessons, themes, etc.
- Design of units and lessons including the structure of each unit and linking of the learning activities
- Design of web pages by modeling the structure and behavior of each page, and designing the items of each page
- Building a prototype based on the design specifications
- Verifying and validating the design by using the prototype that should satisfy all requirements

Production of the Web study guide during the fourth phase includes

- Producing the multimedia items, including animations, images, and audio and video clips
- Assembling the items into the prototype
- Verifying and validating the Web study guide – a final evaluation of requirements fulfillment by developers and testing by real students

The final, fifth phase is delivery. After the Web study guide has been stored on the Web server, it will be accessed by remote students using a Web browser. This phase concludes the development process and begins the maintenance stage.

According to Montilva (2000), *"one of the most important features of the method is its emphasis on the quality of the product"*. The method is specific to Web study guides, and it covers the whole life cycle. Besides, verification and validation processes are used as, *"a continuous activity that has to be performed through all phases of the method"* (Montilva 2000).

3.5 A Model for Component-Based Courseware Development

Baloian et al. (2001) presented a model of courseware development which is based upon a **Component-Based Development model** (e.g., Sommerville 2004) for software. In the presented model, courseware learning goals are managed as if they were user requirements. The model itself is called **Component-Based Courseware Development**.

The presented model uses both incremental and iterative development for building courseware and is based on three main ingredients: an evolutionary methodology, a visual modeling language, and a framework of software components. Methodology guides the development process, and during the analysis and design phases defines a model of the courseware structure or the course curriculum with the visual modeling language. Furthermore, the framework of software components is used for creating the courseware during the implementation phase. According to Baloian et al. (2001), *"this framework supports the different kinds of learning activities that are to be carried out during the course and they also contain the computer-based learning material to be used"*.

The component-based courseware development model exploits patterns to build a courseware and it follows both courseware and software lifecycles that consists of four phases: analysis, design, implementation, and validation (see Figure 10).

The first phase in the component-based courseware development model is the **Analysis phase** which is divided into two sub-phases: the *Scenario Definition* sub-phase and the *Goals Definition* sub-phase. During the first sub-phase, the work scenario is defined. In order to do that, one has to carry out the background analysis that includes: to determine the target audience, identify the available resources for carrying out the teaching/learning process, and to analyze the background information of the course. After that it is possible to determine instructional strategy in use during the course and to apply suitable evaluation methods. Courseware goals are defined during the second subphase and organized into a hierarchical tree.

The second phase of the component-based courseware development model is the **Design phase** which is divided into two sub-phases: the *Means Definition* sub-phase and the *Means Sequencing* sub-phase. During the first sub-phase, the means to attain the proposed goals are defined. During the second sub-phase, the most appropriate sequence or the best schedule to execute the means is designed. Baloian et al. (2001) defines a means as *"a combination of an activity and its associated computer-based learning contents"*.

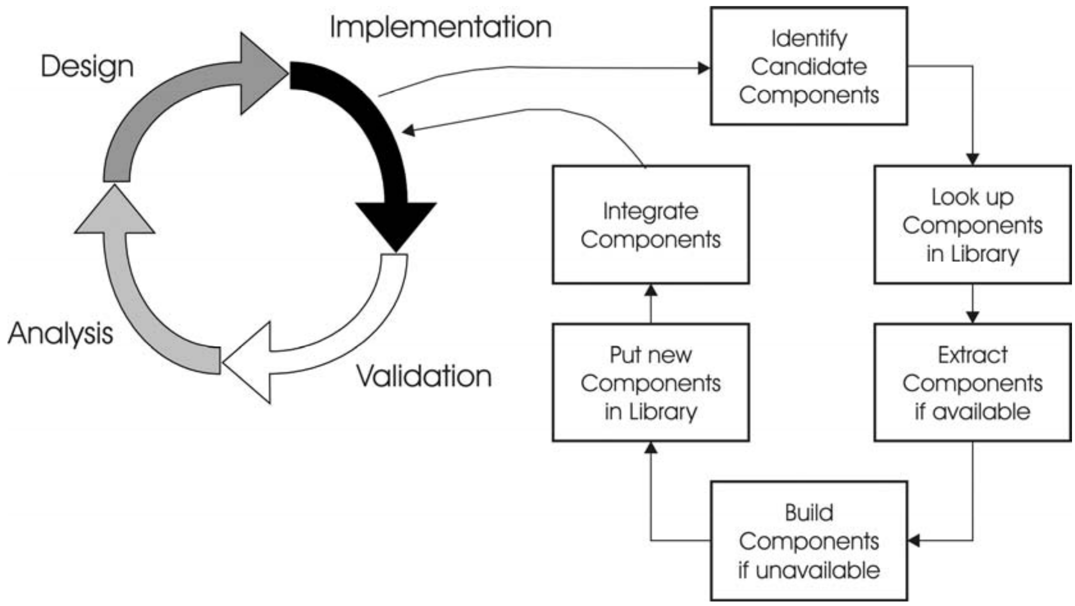

FIGURE 10 Component-based development model by Baloian et al. (2001)

Defining the means in the first sub-phase includes the means (activities and contents) to reach the goals, the relationships among them, the method to validate the attained goals, and the course-ware acceptation criteria. According to Baloian et al. (2001), relationships between means and the duration for each means determine the dynamics of the teaching/learning process. The means are divided into a student means (where students have the main responsible for activities) and an instructor means (where the main responsible is an instructor).

Before ending the first sub-phase, one has to validate the goals by performing a means composition. During the second sub-phase, both the instruction means and the student means are sequenced separately, but both of these sequences must be bonded together to attain the course's means sequence. According to Baloian et al. (2001), *"the sequence of instructor and students means allows the teacher and his/her assistant(s) to know whether the time allotted for each activity is the right one or not, as well as to appraise whether the dynamics of the teaching/learning process is appropriate enough to attain the proposed goals"*.

The third phase of the component-based courseware development model is the **Implementation phase** which is divided into two sub-phases: the *Means Implementation* sub-phase and the *Component Integration* sub-phase. During the first sub-phase, each of the designed means is implemented as an educational component. During the second sub-phase, these implemented educational components are integrated in order to build up the courseware. All of these educational components for any course form a repository and it is recommended to check first, if there are already components that will fit the activities' implementation. A product from this phase is a courseware.

The final phase of the component-based courseware development model is the **Validation phase**. As Baloian et al. (2001) points out, *"the validating phase can be carried out only by using the courseware in a real situation, in order to get a real feedback"*. Furthermore, *"to improve the teaching/learning process, it is very important to identify every wrong or weak strategy in order to replace it and, conversely, every successful strategy in order to repeat it and/or extend it"*.

As a conclusion, this component-based courseware development model covers all lifecycle phases of a courseware by systematizing their development, and the construction of the courseware is carried out by assembling educational components. These reusable components are implemented means which consist of an activity and its associated computer-based learning content. These means are defined in order to reach certain learning goals that have been set down during the *Scenario Definition* sub-phase of the analysis phase. Pedagogical methods are also defined at the beginning of the analysis phase and combined with the content in the *Means Definition* sub-phase of the design phase.

3.6 Summary of existing design processes and models

Key questions for web course design is how to design granular learning material that benefits from using the web and how and when to integrate such a (web-) pedagogic into training that enhances learning. Although being important steps towards a structured method in which to develop web courses, we feel that these two central aspects are not clearly captured in the existing approaches and process models.

Most of these approaches, like those which have been reviewed in Sections 3.3-3.5, seem to be mainly organization-centric (time & schedule drive the development of content that is immediately organized, e.g., on weekly units) and not as much learning-centric. There are some respectable models, e.g., by Baloian et al. (see, Section 3.5) which include also pedagogical issues, but they are excluding variety of different pedagogical solutions already at the beginning of the design process. Then there are also educational models, like the ADDIE Model (see Section 3.2) which are based on Instructional Design. **These models have almost equal phases and activities, but they do not support granularity of learning materials**.

4 LEARNER-CENTERED DESIGN

Most of the virtual learning environments are a compound of the three basic components: *cognitive tools*, *communication tools* and *hypermedia-based learning material* (Multisilta 1997). Of course, virtual learning environments can also be composed of one or more of these parts. Moreover, technical designs might not follow this division because one technical solution (e.g., email) can represent one or more of these parts.

In virtual learning environments a teacher is not physically present (see Section 2.4) so we need tools to support different kinds of learning styles and strategies (Multisilta 1997), and to help students follow the desired learning process more easily (see Section 2.1). Furthermore, to achieve more quality in online learning, the learning environment has to be usable and learner-centered, and the quality of learning material has to be high. As described in Chapter 2, modern pedagogics deals a lot with learning and interaction support, aspects of design that are enabled through these cognitive and communication tools.

Firstly, in this chapter these tools that support and promote learning are introduced. Then, a learner-centered point of view is introduced with human-centered design. Finally, a brief look at usability issues is taken.

4.1 Cognitive and communication tools

Cognitive tools (or problem solving tools) guide and expand the thinking and learning processes of the student (Häkkinen 1996; Multisilta 1997). Lajolie

(1993) describes four categories of cognitive tools on the basis of how computers can be used in different situations:

- **Tools that support cognitive processes**, e.g., memory and metacognition
- **Tools that share the cognitive load**, e.g., the computer carries out lower level tasks for learners thus freeing up attentional resources to accomplish higher order thinking skills
- **Tools that assist the learner to engage in out-of-reach activities**, e.g., by providing simulations with safe opportunities or without physical limitations from the real world
- **Tools that provide support for hypothesis testing**, e.g., by providing multiple hypothesis paths with support or coaching in the context of such hypotheses.

Cognitive tools can also be categorized from other perspectives. Jonassen (1992) lists three dimensions of cognitive tools as follows (Figure 11):

- **The dimension of control:** concerns the control over the learning situation and the artifact is, ranging from total teacher control to total learner control
- **The dimension of generativity:** concerns the view of learning and knowledge, permeating the learning situation, ranging from pure presentation to genuine creation
- **The dimension of engagement:** concerns the way in which learners act in the learning situation, ranging from passive to active.

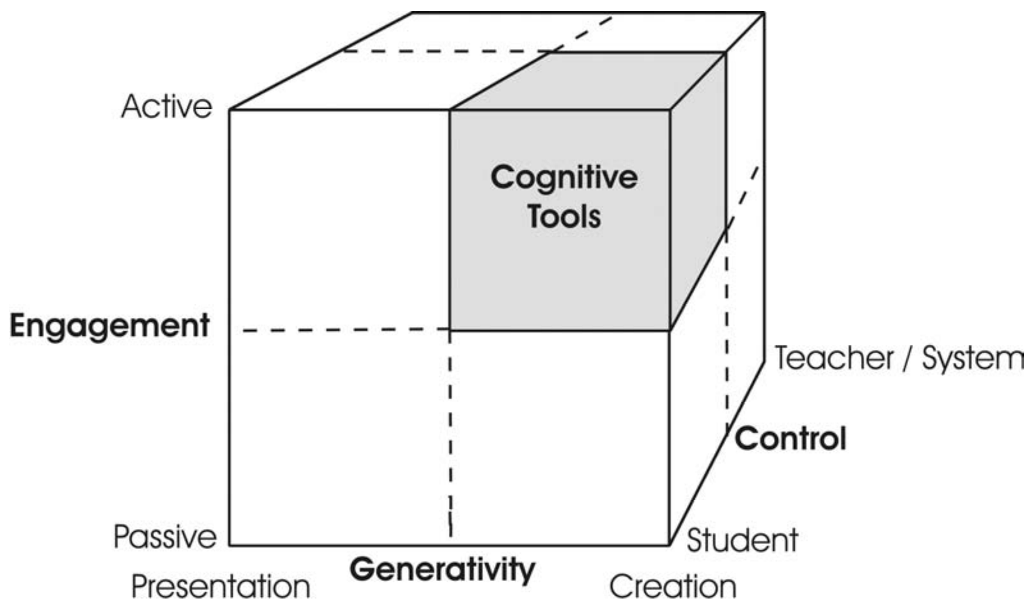

FIGURE 11 Cognitive tools by Jonassen (1992)

Good examples of cognitive tools are tools that support visualization of a concept and their relationships (e.g., concept maps), tools that help student to present the information which he/she has gathered (e.g., tables, mind maps, pictures or simple models), and tools that help students to combine their own knowledge with the new information (e.g., Strauss & Corbin 1998; Puntambekar et al. 2003; Hübscher 1997).

Communication tools enable communication and cooperation between users in a virtual learning environment (Multisilta 1997). Examples of communication tools are e-mail, discussion groups, chat and video-conferencing. Communication tools can be categorized, e.g., from three different perspectives:

- **Time linkage:** asynchronous (different time) or synchronous (concurrent)
- **Direction:** unidirectional (e.g., bulletin board) or bi-directional (e.g., E-Mail)
- **Size of target group:** one-to-one, one-to-many, many-to-one or many-to-many.

Learning in virtual learning environments is mostly based on interactions and knowledge is primarily generated through these interactions (see Section 2.2.6). This creates a huge role for communication tools, and we need to pay special attention in how to communicate and how to get all the students to communicate with each other (as well as with a teacher).

The role of the teacher transforms to a tutor (see Section 2.4) and the need for new tools to guide and help students during their learning process is palpable. Communication tools help, but because students are expected to be more initiative, independent, creative, self-directed, and reflective (see Section 2.2.6) there is an obvious need for cognitive tools also.

4.2 Human-centered design

According to modern learning theories, learning should be learner-centered (see Sections 2.2 & 2.3). This leads us to the fact that learning systems should also be learner-centered. That is why the learner's requirements and activity should be the main objectives in designing learning systems. ISO 13407:1999 standard identifies four main activities of human-centered design for interactive systems (see Figure 12):

- Understand and specify context of use
- Specify the user and organizational requirements
- Produce design solutions
- Evaluate designs against requirements

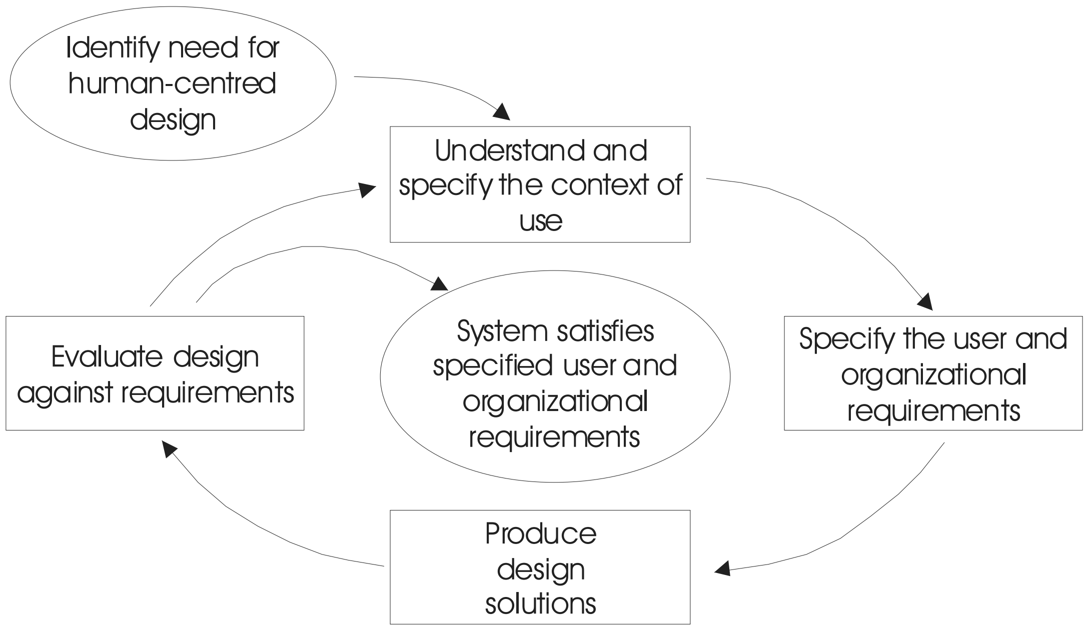

FIGURE 12 The interdependence of human-centered design activities (ISO 13407:1999)

According to ISO 13407:1999 standard, one should in the design phase:

- Use of existing knowledge to develop design proposals with multi-disciplinary input
- Make the design solutions more concrete using simulations, models, mock-ups, etc.
- Present the design solutions to users and allow them to perform tasks (or simulated tasks)
- Alter the design in response to the user feedback and iterate this process (see Figure 12) until the human-centered design goals are met
- Manage the iteration of design solutions

Every design process of learning environments should also follow these basic ideas of human-centered design.

4.3 Usability and pedagogical usability

Nowadays in web course design, as in software development, usability is one of the key issues with multiple components; it is not just a single, one-dimensional property of user interface. Usability has been defined by Jacob Nielsen (1993, 2000), Brian Shackel (1991), and in ISO 9241-11:1998 standard. This work considers only Nielsen's definition that defines **usability** with five attributes:

- **Learnability** – the system should be easy to learn

- **Efficiency** – the system should be efficient to use
- **Memorability** – the system should be easy to remember
- **Errors** – the system should have a low error rate, and if a user makes errors he or she can easily recover from them
- **Satisfaction** – the system should be pleasant to use

In learning systems, pedagogical issues, such as support for learning, are important. Horila et al. (2002) combined Nielsen's usability attributes with Jonassen's qualities of meaningful learning (see Section 2.2.2) and defined the criteria of pedagogical usability for digital learning environments. In their approach, **pedagogical usability** consists of the following 11 concepts:

- **Learnability** – is it easy to learn to use the system?
- **Graphics and layout** – how different pictures and figures have been joined into other elements of the system?
- **Ease of use: technical and pedagogical approach** – can the user use the system independently? What kinds of support processes are needed?
- **Motivation** – how to motivate the system and its content?
- **Applicability** – how well are different learning situations and different kinds of learners supported by the system?
- **Technical requirements** – are there enough computers available for students, do teachers and students have the proper equipment, and does the system work in a stable way?
- **Sociality** – is the system designed for individual learning or is the social activity between teacher and students considered in the system?
- **Interactivity** – is there some interactivity included in the system?
- **Objectiveness** – is the system target-oriented?
- **Added value for teaching** – how beneficial is the system by means of all the work that its use requires?
- **Intuitive efficiency (teacher, student)** – are the users willing to use the system, how effective is it from the users point of view?

Pedagogical usability is a concept that forms a kind of bridge between pedagogical and technical design in virtual learning environments. The given attributes are also useful in the assessment process, although, it seems that some parts of the proposed definition by Horila et al. (2002) are not on the same level of abstraction than the other parts or the underlying theories by Nielsen and Jonassen (see Figure 13). More precisely, *Technical requirements* and *Graphics and layout* are technical prerequisites or means to support the other, more general objectives while *Motivation*, *Applicability*, *Sociability*, *Interactivity*, *Objectiveness*, and *Intuitive efficiency* have strong connections forming the base for design. This is also clearly visible in Figure 13.

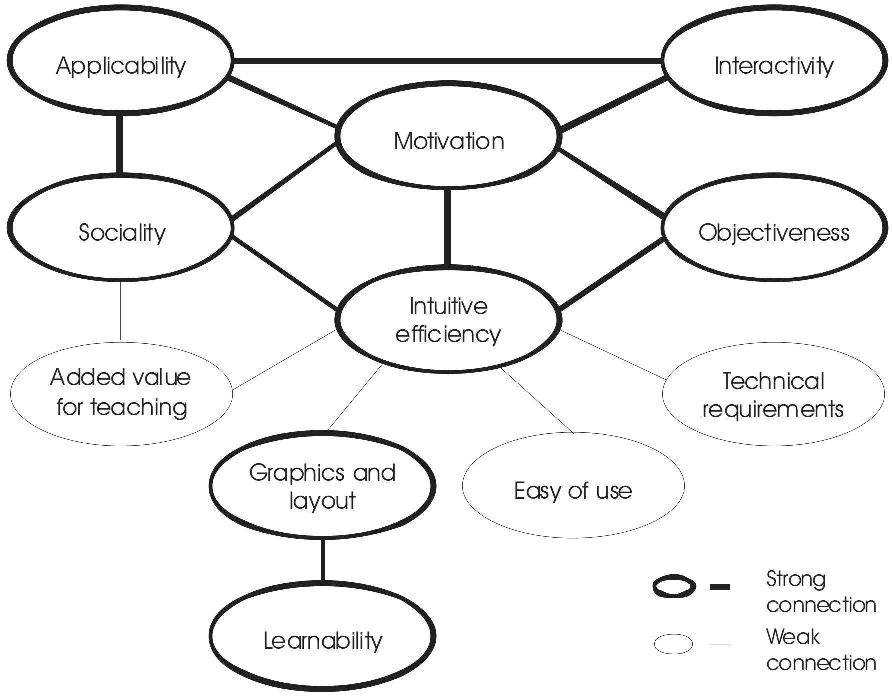

FIGURE 13 Connections between concepts of pedagogical usability (Horila et al. 2002)

4.4 Summary of design base

The modern pedagogics desire learner-centered learning environments with interaction between students as well as between a student and a teacher. Most of the knowledge is formed through these interactions. In virtual learning environments the teacher is not physically present so we need cognitive and communication tools (see Section 4.1) to support learning and teaching. Learner-centeredness (see Section 4.2) and (pedagogical) usability issues (see Section 4.3) also form the base for web course design. Careful designs raise the quality of learning.

5 QUALITY IN ONLINE LEARNING

Quality is often used to signify "excellence" of a product or service – how useful it is in its management (Oakland 1993). This leads us to the recognition of true requirements of the "customer" – the needs and expectations. *"Quality … is simply meeting customer's requirements"* (Oakland 1993). Quality is important nowadays as is quantity in the public sector as well as in education. Quality is still one of the biggest unsolved problems in online learning – we are not even sure what quality means in this context. This chapter concentrates on quality issues - what is quality and how can it be measured or evaluated in online learning.

5.1 Quality and quality assessment in general

Traditionally quality has been an essential part of the products or services. Part of the acceptability of the product or service depends on its ability to function satisfactorily over a period of time. This aspect of performance is called *reliability;* ability of the product or service to continue to meet the customers requirements. (Oakland 1993)

In software engineering quality has been defined in several standards and criteria. One of the quality standards is ISO/IEC 9126-1: 2001. It defines six product quality characteristics (see Figure 14) which do not provide requirements for software, but define a quality model that is applicable to every kind of software. Furthermore, Bach has defined quality criteria categories which are *"designed to evoke different kinds of requirements"* (Bach 1999). These criteria are defined as follows:

- *Capability* - can the software perform the required functions?
- *Reliability* - will the software work well and resist failure in all required situations?
- *Usability* - how easy is the software for a real user to use the product?
- *Performance* - how speedy and responsive is the software?
- *Installability* - how easy can the software be installed onto its target platform?
- *Compatibility* - how well does the software work with external components and configurations?
- *Supportability* - how economical will the software be to provide support to users of the product?
- *Testability* - how effective can the product be tested?
- *Maintainability* - how economical will the software be to build, fix or enhance the product?
- *Portability* - how economical will the software be to port or reuse the technology elsewhere?
- *Localizability* - how economical will the software be to publish the product in another language?

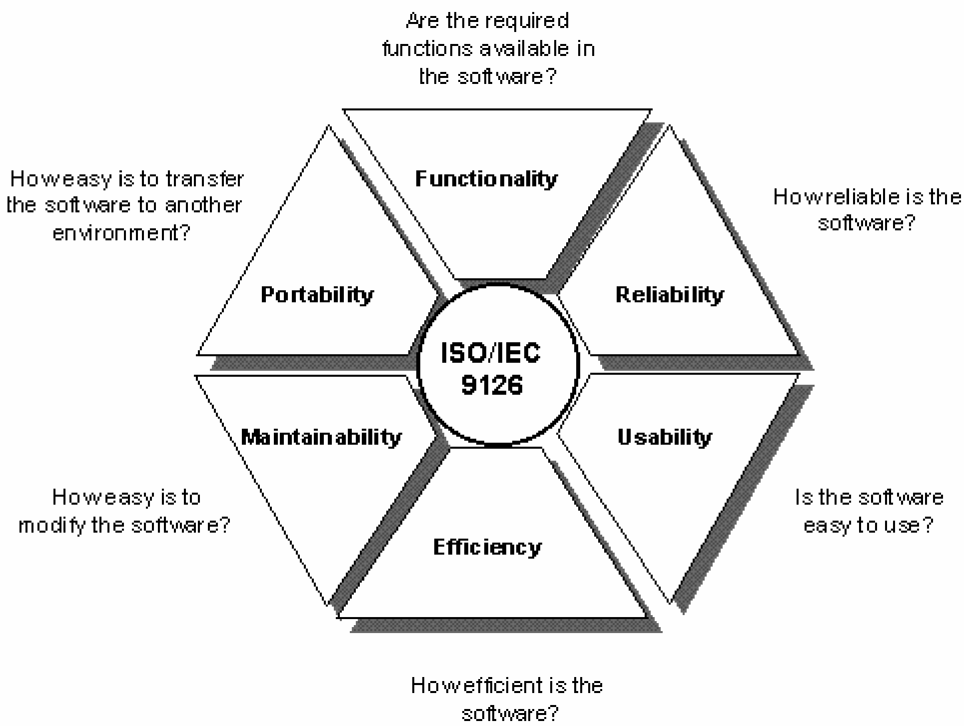

FIGURE 14 The six quality characteristics of a software (ESSI-SCOPE 2005)

The European Foundation for Quality Management (EFQM) has created a model that will help organizations in the process of self-assessment to improve performance. This model, called *"The EFMQ Excellence Model"* is based on nine quality criteria: *leadership*, *policy and strategy*, *people*, *partnership and resources*, *processes*, *customer results*, *people results*, *society results*, and *key performance results* (EFMQ 2003). This model has formed the basis for the so-called *"CAF Model"* that was created by the IPSG (the Innovative Public Services Group, a working group of EU member countries). The Common Assessment Framework (CAF) is a self-assessment tool for public sector organizations across Europe for quality management, and in that way to improve performance (CAF 2002). The nine-box structure (see Figure 15) identifies the main aspects requiring consideration in any organizational analysis. Within each of these boxes a list of criteria is provided, and the main issues that need to be considered when assessing an organization are identified (CAF 2002). The CAF is also used at universities to assess the quality of management and education performance (e.g., Quality system of the University of Jyväskylä).

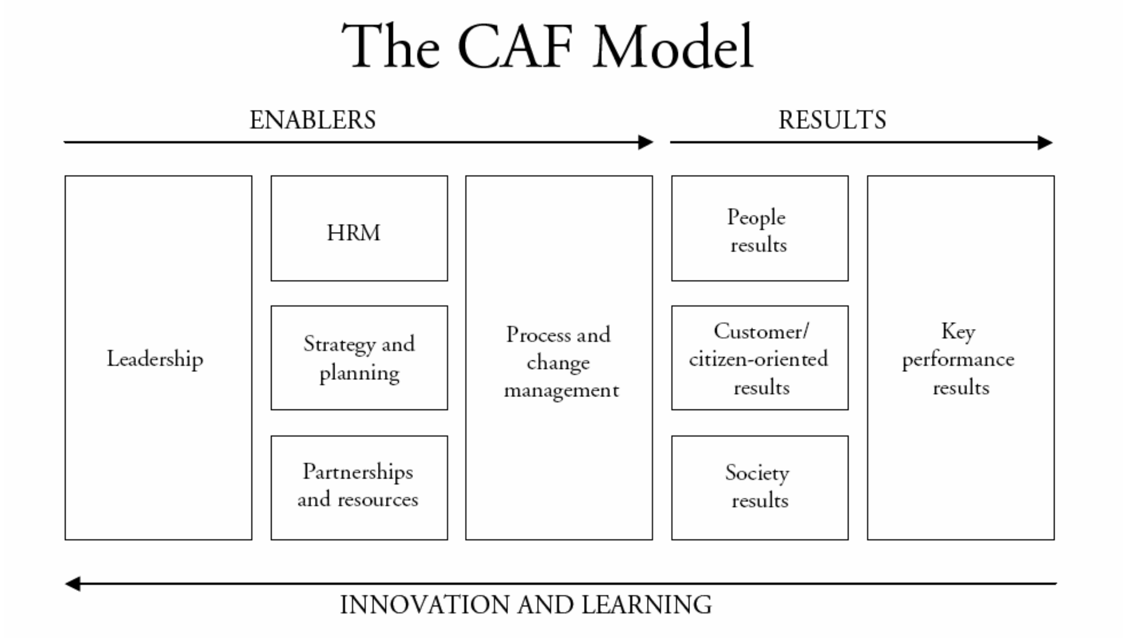

FIGURE 15 The CAF Model (CAF 2002) in which HRM means human resources and management.

5.2 Quality assessment of learning

Two the most traditional ways to assess quality in learning are *learning outcome* and *satisfaction of students*. A survey made by Allen & Seaman (2004) in the USA shows that a majority rate of online learning outcome is equivalent to face-to-face learning, and that *"a large majority of all institutions agree that students are as satisfied with online courses as they are with face-to-face offerings"*, but is this all that we are going to get? As McDonald (2002) questions in her article, *"is 'as good as face-to-face' as good as it (online learning) gets?"* Is there some other way to measure the quality of online learning than comparing it with face-to-face learning? Of course, we can compare some single functions like the learning outcome between classroom discussions and online discussions, but not the learning process as a whole. Besides, according to Silius et al. (2005), *"quality of education experienced by students is quite subjective; it depends a lot on students' prejudices"*. Moreover, *"students compare their experiences with expectations they had while they form their opinions about the quality of education"*.

We have new technology in our hands, but we use it just to do old things differently. Instead of doing this, we should focus on doing new things in new ways (e.g., McDonald 2002) – this applies to quality issues too. As McDonald (2002) points it out, *"Internet-based education is evolving its own pedagogy that is challenging traditional education"* – if we just let it happen. As mentioned earlier (see, Sections 2.2.6 & 2.3.2) new technologies enable new kinds of educational methods and new ways to utilize these; we should start to design "new" kinds of learning environments online. This leads us to the need to utilize new kinds of quality indicators as well.

5.3 Improving learning outcomes

A good learning outcome is as important in online learning as in the traditional classroom environment, and it will always be one of the quality indicators in learning - we just need to reform it a little bit.

First of all, to ensure successful learning in an online environment teachers should inform students in advance what they are expected to do and how (Yang & Cornelious 2005). Since face-to-face learning is usually eliminated in online learning, it might be more difficult for a teacher to get sufficient information on how well learners are actually performing. This problem can be passed with new evaluating methods, phasing of learning, and different sorts of learning assignments which measure the learning outcome through learners' deep learning, higher order thinking, critical thinking, or problem-solving skills. Teachers must also ensure that the students' learning outcomes can be achieved (Yang & Cornelious 2005). The expectations of a learner should also *"be taken into account in order to better help students achieve the required learning outcome"* (Jin & Hill 2001).

A drawback of recent quality assessment research has been the fact that we are not going to achieve enough information if we are just comparing the outcome results of traditional learning (e.g., Allen & Seaman 2004); or at least we should not get comparable results because learning situations, learning materials as well as pedagogical solutions should be different (see Chapter 2). If we just transform the classroom environment into digital form, we miss most of the potential that online learning can or could offer. As Flagler (2002) clearly points out, *"the learning outcome is clearly only as good as the content will allow"*, but *"with* *rigorous, pertinent, learner-centric content, maximization of the learning outcome is possible"*. To support learning outcome in online learning designers have a lot to do and they also have a huge responsibility.

One of the biggest problems that affects negatively on the outcome of a students' learning in online learning is the lack of information (Twigg 2001b). Students are not able to find enough information about the quality of courses that are provided. Moreover, prerequisites that are essential for taking the particular course are very often insufficient or unclearly stated on course websites, and students do not know where to ask and get help, e.g., in technical problems (Twigg 2001b). As Yang and Cornelious (2005) remind us, *"instructors need to seriously consider what they can do and should do to provide quality online instruction that students deserve"*.

The content of the online course should be compelling – that makes it interesting and keeps students coming back (Flagler 2002). By the words of Flagner, *"a learner must be engaged by the delivery mode in order to remain interested in the curricula"*. Furthermore, a learner must know what there is for him/her. The content must be practical and useful, and it should provide a clear purpose, and of course, it has to include measurable objectives so that the learner is able to follow his/her own progress in learning. All this makes the virtual learning environment motivational. (Flagler 2002)

Once learners are motivated, we have to get them more initiative, independent, creative and reflective so that they are able to be personally responsible to learn and develop (see Section 2.2.6; also Flagler 2002). Learners must be able to seek, use, adapt, criticize, process, and yield information, not just memorize information that has been delivered to them. Also, *"learners need to rely on cognitive skills to self-monitor the learning experience, to make decisions about learning needs, to decide upon the appropriate resources and the course of action to take that best meets the learner's needs"* (Flagler 2002). How are designers able to do all this? By implementing challenging content and encouraging learners to use other resources too, we help them to build a wider knowledge base. With phasing and sub-goals we offer knowledge acquisition checkpoints which allow learners to self-assess and self-reflect. By offering multiple learning paths and variety on levels of difficulty, we allow individual differences (which also supports different learning styles better). By developing *"content in which learners must define problems, generate solutions, implement those solutions, and then see the outcome of the decisions"* we provide opportunities for decision-making that also support a students' self-reliance as well as self-confidence (Flagler 2002).

To assure that all students have equal learning possibilities, we have to support multiple learning styles and build opportunities for success. We should also allow learners to manage the learning process by creating content that is *"reflective, self-customizable, self-paced, and contains measurable milestones"* (Flagler 2002). We should also encourage learners to make mistakes and to learn from them.

According to modern learning theories (see Chapter 2) the key to successful learning is interaction. This should be one of the key elements in online learning as well. We can *"assist the learner and alleviate risks by encouraging all* *forms of communication, providing diverse situations, allocating opportunities for reflection and interaction, and expecting feedback and responding responsibly to that feedback"* (Flagler 2002).

5.4 New indicators for quality in online learning

As mentioned in the previous section, the **learning outcome** will always be the first quality indicator while evaluating the quality of learning, but to ensure good learning outcome we need good teachers.

According to Rice (2003), the single most important factor affecting student achievement is teachers, and the most important predictor is teacher quality. Moreover, according to several studies reported by Kleinman (2004), professional development of the teachers is more effective when it *"fosters a deepening of subject-matter knowledge, a greater understanding of learning, and a greater appreciation of students' needs"*, and *"centers around the critical activities of teaching and learning – planning lessons, evaluating student work, developing curriculum, improving classroom practices and increasing student learning – rather than on abstractions and generalities"*. How will this change while we move into the virtual learning environment? Teachers need all kinds of pedagogical and didactical skills online as well as in the classroom, but environments change. A teacher has to be able to adapt these educational competences into a new context (e.g., Tella et al. 2001; Vahtivuori et al. 1999). Moreover, they need to adjust their attitudes towards technology and new teaching styles to meet the challenge (Webster & Hackley 1997).

There is a lot of research evidence which shows that the role of the teacher in online learning is very essential, and the need for teacher and guidance is even growing compared to traditional classroom learning (e.g., Kynäslahti & Wager 1999; Luukkainen 2000). There is also the evidential need for computational skills of teachers, because the whole learning takes place in a computer-based environment (e.g., Tella et al. 2001; Volery & Lord 2000). Teachers need to know how to design interactive activities and course syllabi, how to operate with the learning platform, and troubleshoot problems that online learners may encounter (Cuellar 2002). Thus, second quality indicator should be **the computational, contentual, educational and instructional competence of online teachers, and how well he/she is able to utilize these while teaching**.

According to Yang and Cornelious (2005), to ensure the quality of online learning teachers need to adjust their attitudes to teach online, understand what qualifications are needed (see Section 2.4) and to know what they can do to ensure high quality. Moreover, teacher's attitude, motivation, and true commitment affect a great deal on the quality of online learning (Deubel 2003). Furthermore, according to Silius et al. (2005), *"expectations created by the image of our information society influences so much on online learning that students have started to require quality in online learning based on several different criteria"*. We have to identify the needs and expectations (requirements) of all types of students with different kinds of learning styles, and fulfill these needs by designing virtual learning environments that measure up to all these requirements (e.g., Yang & Cornelious 2005). Thus, a third indicator for quality in online learning should be the **identification of different student groups and how well online learning serves the learning needs of these different student groups**.

Quality in learning material means that no more "page-turning or scroll-down architectures" where learners just press the buttons for the next page or scrolls down on the screen (e.g., Schank 1993). We need more than just "translation" of books and lectures into an electronic format (Bork 1986). We need online courses that teach, not just web pages that present information (Schank 1993). Moreover, an online course should be easy to use, be motivational and interactive (e.g., Horila et al. 2002; Section 4.3). Thus, the fourth quality indicator for online learning could be **how well structured, designed, and usable the learning material itself is**.

The content must also be informative, clear, well-written, and fit for students pre-knowledge. Thus, the fifth indicator could be the **effectiveness and informativeness of the online content**.

There is a need for courses that are based more on learning concepts (Schank 1998). Moreover, students need to be more active while they learn; not just passive "TV-viewers" (Schank 1998). Students will learn by doing, by accomplishing tasks; not by being told (Schank 1993 & 1998). We need to pay more attention on structures and activities while designing online courses so that these would work well with diverse types of students (Twigg 2001a). Thus, the sixth indicator could be **how the online course is pedagogically designed**.

In Section 2.4 we have already discussed the role of the teacher and the fact that in the virtual learning environment learning is mostly carried out without a teacher being physically present. With good, clear and unambiguous instructions students can be guided to be more self-reflective, to avoid possible problems and to follow the desired learning process. This leads us to the seventh indicator that could be **effectiveness of instructions**.

These indicators presented here have not yet been tested, but they do follow from a natural generalization of all the references.

5.5 Summary of quality issues

Learning is changing as well as teaching and content online, so we should also change those indicators that are used for measuring or evaluating the quality in online learning. Quality as well as the effectiveness of an online course is hard to tie down, but in this thesis the following indicators are suggested:

- Learning outcome
- Identification of the computational, contentual, educational and instructional competence of online teacher, and examination of how well a teacher is able to utilize these while teaching

- Identification of different student groups and examination how well online learning serves learning needs of these different student groups
- Structuration, design and usability of the learning material itself
- Effectiveness and informativeness of the online content
- Effectiveness of pedagogical solutions made during the pedagogical design
- Effectiveness of instructions

6 A TOPIC-CASE DRIVEN DEVELOPMENT PROCESS

The main constructive ingredient of this work is to describe such a web course design and development process for web course design that, firstly, allows well-managed integration and incorporation of structural and multigranular digital material with pedagogical knowledge as well as, e.g., communication and cognitive tools. Secondly, it utilizes metaphors from software engineering, i.e. Unified Process. In particular, the proposed methodology naturally supports the utilization of large, possibly distributed team of domain experts for creating the key content. Moreover, it supports structural and incremental development and reusability of the resulting materials as suitable learning objects. Finally, it also supports blended learning as well. This proposed approach, called Topic-case driven methodology for web course design and realization, was internationally introduced in ICNEE 2004 (Hiltunen & Kärkkäinen 2004).

The proposed approach utilizes metaphors from software engineering (following Unified Process, see Section 3.1) to describe a unified way to design and realize web courses, but this approach is blended together with educational (especially pedagogical) issues. Different to the Unified Process, the proposed approach is topic-case driven and content-centric. In general, this web course design and realization process contains five phases: *Background study*, *Content design*, *Pedagogical design*, *Technical design*, and *Realization and assessment* (see Figure 16). The presented approach allows incremental and iterative development of the web course (again following UP). Moreover, it can be utilized as a content development mini-project within other similar methods, e.g., by White and Montilva (see Sections 3.3-3.4).

In the following sections each phase is depicted in more detail using general activity and phase product descriptions. Exact tasks, management responsibilities and precise roles in each activity are not defined, because they all depend on organizational issues and the actual environment for carrying out the development project. Moreover, due to the same reason all kinds of metadata that could and should be documented as part of the development is also left aside.

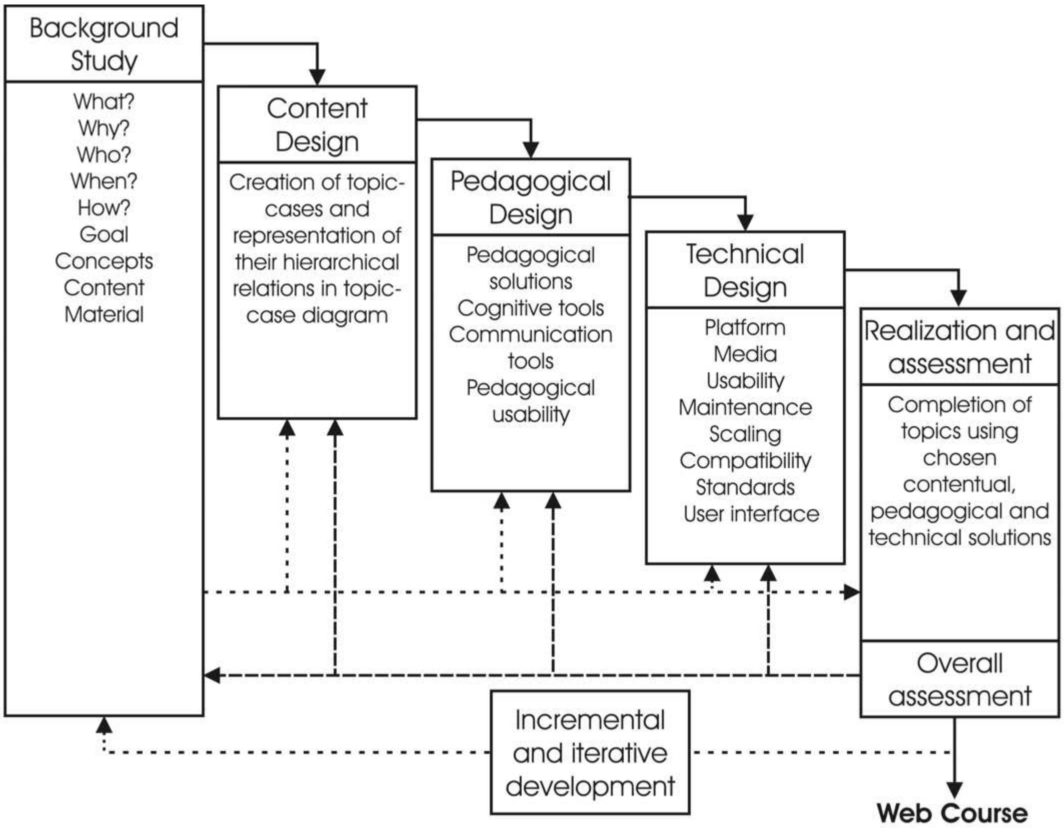

FIGURE 16 Phases of topic-case driven web course design and realization process

6.1 Background Study

The first phase in our web course design and realization process is **the background study**. Similarly to some of the existing models and approaches (see, Sections 3.1-3.5), one has to consider several issues before starting the construction of a web course.

The central task in the background study is to define and consider all these issues that affect the feasibility of the planned web course (Table 3).

TABLE 3 Questions to consider during the Background study

- Why are you designing a web course? What are the benefits compared to a traditional classroom course? (In our approach a web course is not a must but an option and/or a possible enhancement of the traditional classroom course.)
- How are you using the web? What is the role of the web? Is the course (or actually parts of it) going to be an output (static) or a process (dynamic)? (Hein et al. 2000) How highly structured the course (actually parts of it) be and is there going to be dialogue or not? (Moore 1983)
- What is the target group? Who are the students? What kind of learning strategies and learning styles do they use? (see Sections 2.1 & 5.3)
- How much time and resources do we have?
- What kind of technical infrastructure do we have at our disposal?
- What are the basic ideas, focus, and goals of the course?
- How do you handle copyrights and agreements, e.g., concerning content creation?
- Are there some organizational regulations that might affect the design process, e.g., support only for certain learning platforms?

All information about organizational design principles, copyright regulations and design standards should also be considered and documented for further use. As a result of this phase one should have a project plan with timetable, resource allocation, financing plan, possible limitations and baselines of the course. During the background study a useful technique for creating a general view on the content of a course is concept mapping (e.g., Novak 1998; see Figure 17).

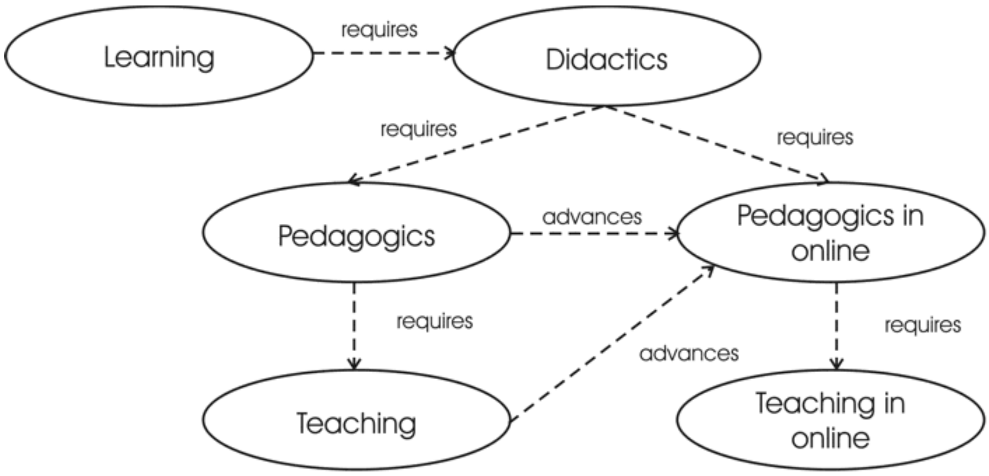

FIGURE 17 A part of the concept map on Virtual Learning Environments

6.1.1 Software Engineering metaphor: Feasibility study

The background study corresponds to the feasibility study in software engineering processes (e.g., Jaaksi et al. 1999; McConnell 1998). In software projects, after identifying the scope one should think about whether the project is feasible. Putnam and Myers (1997) point out that *"not everything imaginable is feasible"*. They also list four solid dimensions of software feasibility: technology, finance, time and resources. These dimensions are also visible in (web) course design. One should find out if ones own ideas are technically, financially, and pedagogically feasible, and whether enough time and resources (skills) are available to carry out the whole project.

6.2 Content Design

During the content design phase one designs and documents the basic content of the web course. During content design the goal should be to design high quality learning materials that are able to achieve a good learning outcome; *"a learning outcome is clearly only as good as the content will allow"* (Flagler 2002; see also Sections 5.2 & 5.3). The phase is divided into two activities: *describing topics of a web course on a general level* and *finding relationships between individual topics*.

6.2.1 Description of topics

Creation and documentation of topics is obtained through the following basic steps:

1. Generation of the basic set of topics with basic attributes
2. Selection, modification and possible combination of the basic topics to create a non-overlapping structured description of contents

The method to describe the contents of a web course at a general level is **topic-case**. Topic-case is a short but structured description of basic lines of the single course topic (or the course itself in the beginning). With topic-cases one first describes the necessary issues that should be treated during the course. Hence, topic-cases form the skeleton of contents of the course (cf. software architecture). Later one adds more features to them, such as pedagogical ideas concerning the realization of topic-cases.

Topic-cases can be documented using suitable forms capturing the necessary attributes during the cumulative development process. The initial topic-case descriptions (see Figure 18) can be formed during the early planning stage (central ones already during the background study). One begins by creating separate topic-cases (using independent and possibly distributed team of content experts if desired) from single issues and then linking them according to preliminary knowledge and pursued learning.

Topic-cases are authenticated with numbers (and names) that also describe the amount of topic-cases, help to evaluate the timetable of the course, and can be used for defining the presentation order of topic-cases. Naturally names and creators of topic-cases should also be documented. Materials engaged with topic-cases can be in any form e.g., books, articles, video clips, recordings. As noticed, Humphrey (1998) uses similar kinds of course descriptions in connection to software engineering courses with four attributes: *Objec-*

tives, *Prerequisites*, *Course structure*, and *Course support*. Formally, the definition of a set of attributes defines the interface of a topic-case (cf. component and class signatures in software engineering).

Name of the course

Topic-Case number: 1

Date / Name of the developer

Topic-case:	Name of the topic-case
Summary:	Brief description of the topic-case
Preliminary knowledge:	Knowledge which is required before entering the topic-case
Material(s):	Material(s) engaged with the topic
Learning:	Sort of post-conditions, learning which is pursued after completing the topic-case

FIGURE 18 Form of basic description of topic-case

6.2.2 Software Engineering metaphor: Use-case

Jacobson et al. (1999) describes the **use-case driven software process** where use-cases are used to capture different requirements, bind development processes together, and help to facilitate iterative development. In use-cases there are usually "attributes" like actor(s), summary, pre-conditions, operations and post-conditions. Unlike use-cases the presented approach does not use actors in topic-cases at this point, because their roles depend on the pedagogical solutions to be developed later.

Use-cases are the drivers of software development in UP, so the presented approach introduces topic-cases as content development drivers for the web course design. In Table 4 the intimate relationship between these two approaches are presented.

TABLE 4 Similarities between use-case and topic-case approaches

Role of	Unified Process	Topic Case Driven Process
Use-case / Topic-case	"A piece of functionality that gives a user a result of value"	A piece of content that gives a student a topic of value
Use-case diagram / Topic-case diagram	"Describes complete functionality of the system … What is the system supposed to do (for each user)?"	Describes complete content of the web course … What is the web course supposed to teach (for each student)?

6.3 Relations between individual topics

After finishing with the first set of individual topics one has to find possible relationships between them to decide which one should be developed further during the current iteration. The creation of these relations is based on the prerequisite knowledge and pursued learning of each topic-case as documented in the basic form. Firstly, though, one seeks the sub-groups of topics that are so similar that it is better to merge and join them together as a single topic-case.

The topic-case relations are represented in the **topic-case diagram**, which defines the basic contentual hierarchy of the web course, serving as a more precise content map (see Figure 19). For describing the relationships between different topic-cases new stereotypes are introduced: **«requires»** and **«advances»**. **«requires»** indicates what knowledge is required before a certain topic-case can be accomplished properly. **«advances»** indicates the knowledge that would be usefully available, but is not compulsory for the following topic-case.

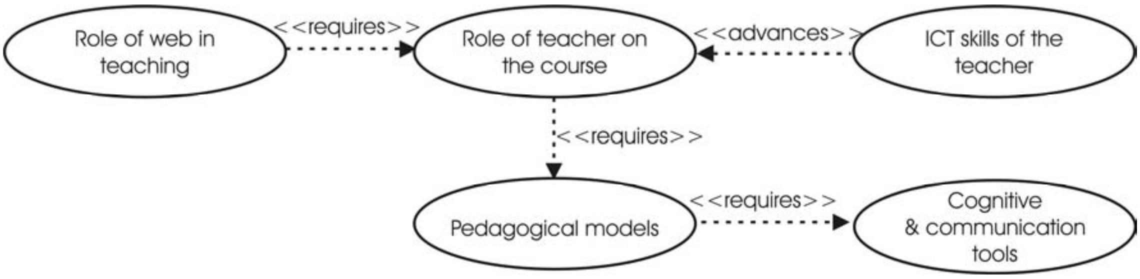

FIGURE 19 An example of topic-case diagram with five topic-cases

Using the given stereotypes a topic-case diagram reveals which topic-cases are essential to the main concepts in the concept map of the course and which are prerequisites for other topics. This yields a natural way to select those topic-cases that must be implemented first (under the time and resource limitations). The remaining topic-cases that extend the basic knowledge can be implemented during the later iterations or can be used as a subject of term papers or exercises.

This activity should result in a topic-case diagram that describes realizable topics and relationships between them. After the content design phase all topic-case descriptions, with a topic-case diagram, present the basic content of the web course. For example, the course syllabus is then just (one) transformation of the content to lessons in the (virtual) classroom, e.g., on weekly units.

6.3.1 Software Engineering metaphor: Use-case diagram

Jacobson et al. (1999) defines the use-case diagram as a model that *"describes the complete functionality of the system"*. This model answers the question: What is the system supposed to do (for each user)? An example of a use-case diagram is shown in Figure 20.

Use-case diagrams usually contain three kinds of stereotypes: **«uses»**, **«include»** and **«extend»**. These notations describe the nature of the relationship between the two use-cases.

Before creating the use-case diagram one needs to do some kind of evaluation and select a limited amount of realizable use-cases. Bass et al. (1998; Chapter 9) presents an evaluation process of scenarios (a scenario is a brief description of some anticipated or desired use of the system) in connection with choosing the appropriate software architecture. Their approach is readily applicable for evaluation of use-cases (as well as topic-cases). Evaluation process of Bass et al. (1998) proceeds as followed:

- **Classification of scenarios:** can the system execute scenarios directly or indirectly (without any modifications to the system (content) or with some modifications)?
- **Individual evaluation on scenarios:** what kinds of changes are needed for the system (content) to support the scenario?
- **Assessment of scenario interaction:** what kind of interaction is required between scenarios and the system (content)?
- **Overall evaluation:** how important are the scenario interactions for the activities you expect the system (content) to be able to perform (contain)?

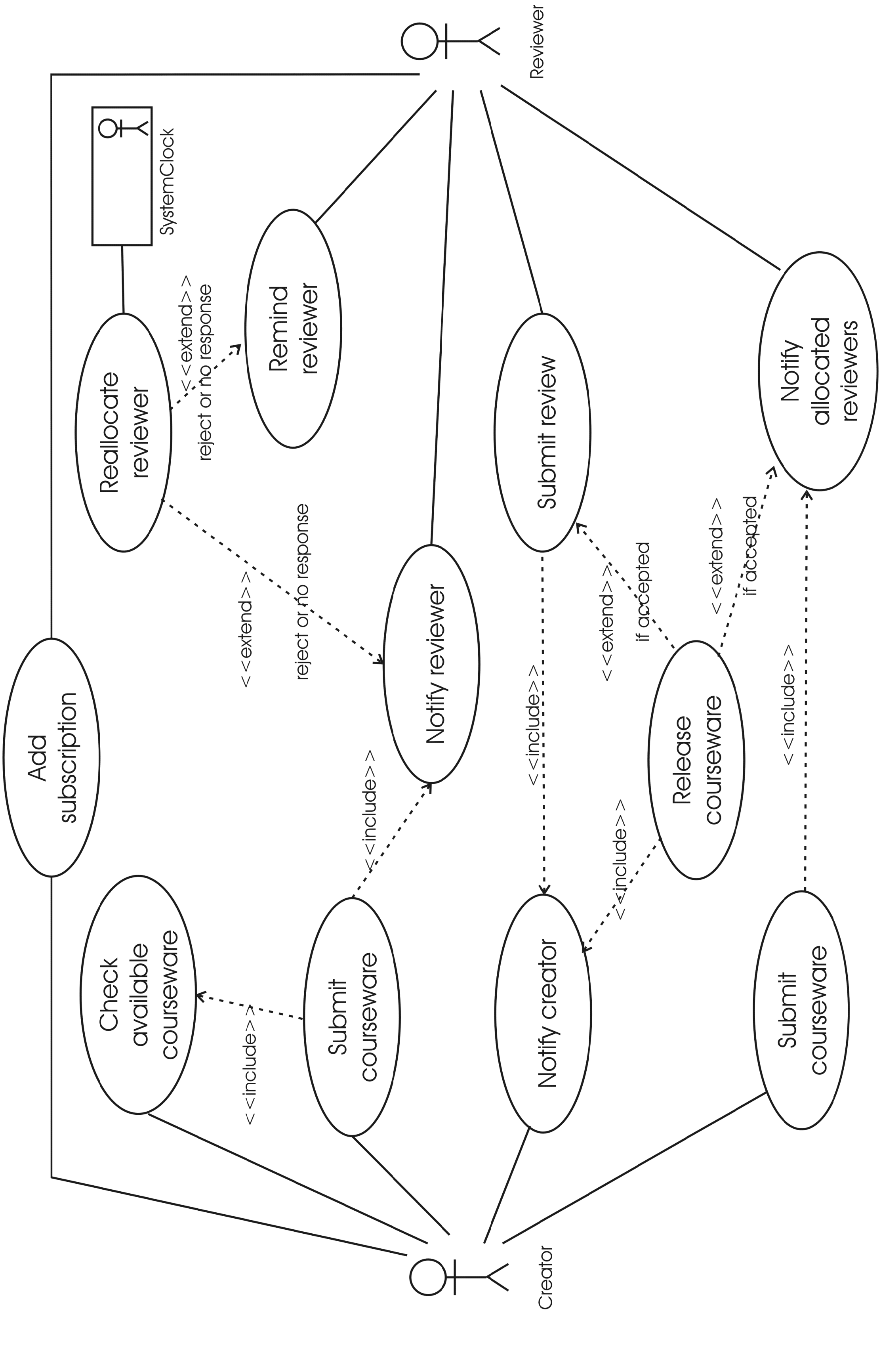

FIGURE 20 Partial use-case diagram of community based learning object repository with eleven use-cases and two actors (Box 2004)

6.4 Pedagogical Design

Pedagogical design is usually forgotten in web course design. One reason for this could be the fact that pedagogical design is definitely not easy. Another reason could be that web-designers usually do not have a pedagogical background. In the presented approach the individual phase for pedagogical design ensures that this issue, which should underlie all teaching activities, has its special role within the web course design. The preliminary knowledge behind a successful pedagogical design was summarized in Chapter 2.

6.4.1 Questions behind pedagogical design

What kind of learning do we support in our web course: instrumental, communicative or emancipatory (see Section 2.2.4)? What is a suitable pedagogical approach for each topic: instructional, cognitive, constructive, humanistic, critical humanistic learning or something else (see Sections 2.2.5, 2.3.2)? What forms of activity do we use (see Section 2.2.2)? What kinds of media do we utilize in our course (see Sections 2.1 & 2.2.6)? These are the basic questions which have to be considered next.

Pedagogical problems are usually related to roles of teachers and students (see Sections 2.2.6 & 2.4), ways of teaching and learning and actions in those situations (see Sections 2.2.2, 2.2.3 & 2.4), learning tasks with different characteristics, guidance and control in learning (see Sections 2.4, 5.2 & 5.3), assessment (see Section 2.5), and feedback. In addition, pedagogical design includes the integration of communication and cognitive tools into the web course (see Section 4.1) and consideration of pedagogical usability (see Section 4.3). All of these pedagogical issues should be considered and written down during the pedagogical design phase. Some of these issues have been brought up already during the background study, but at this point each topic is connected to its pedagogical solution.

6.4.2 Pedagogical solutions for each topic

After the content design phase one has selected topics for the current iteration that should be augmented with advisable pedagogical activities to support and to describe teaching and learning of that topic. In this phase educators augment these topics with advisable pedagogical activities.

To document the decisions made, the presented approach extends the topic-case descriptions (cf. Figure 18) by adding a few more attributes that describe in more detail what teachers and students should do and what kind of teaching and learning activities are recommended. Hence, new attributes: *Actor(s)*, *Description*, *Pedagogical solution(s),* and *Relations*, are filled in each topic-case. Moreover, each topic-case may have more than one possible pedagogical solution. In some cases it might be better for (different) students to be able to see a topic from different perspectives to support their individual learning styles (see Sections 2.1 & 2.2.6). Pedagogical solutions contain both teaching and learning activities, and recommended assignments for learning session.

Relations to other topic-cases are important. These relations identify links between different topics for the technical design. They are also useful if one has to update the contents later on.

After this phase one should have documented the content of the web course and pedagogical activities for each topic, which are represented in the **extended topic-case descriptions** (Figure 21; extensions are marked with bold).

Name of the course
Topic-case number: 1
Date / Name of the developer

Topic-case:	Name of the topic-case
Summary:	A brief description of the topic-case
Actor(s):	**Actor(s) involved in the topic-case (teachers and students)**
Preliminary knowledge:	Knowledge which is required before completing the topic-case
Description:	**Detailed description of the activity in topic-case**
Pedagogical solution(s):	**Pedagogical solution(s) in topic-case, learning and teaching methods and activities used**
Teaching:	**Advisable teaching actions in topic-case**
Learning:	**Advisable learning actions in topic-case**
Assignments:	**Advisable learning assignments with this topic**
Material(s):	Material(s) engaged with the topic
Learning:	Post-conditions, learning which is pursued after completing the topic case
Relations:	**Relations to other topic-cases**

FIGURE 21 Form of the extended topic-case

6.4.3 Software Engineering metaphor: Usability design

In software projects usability is one of those issues that should be considered during the process in order to develop a usable and well-designed product. Hakiel (1997) presents two contrasting approaches in regards to how usability can be integrated in software engineering:

1. Usability design deliverables are aligned with software design deliverables
2. Usability design deliverables are contributing to software requirements

These approaches also conform to pedagogical design; *pedagogical issues should and can be taken into account at the beginning of the process or during the pedagogical design*. If a web course design is based on strong pedagogical models, these can be the ultimate drivers for the whole design process (see Figure 22). Concerning the extended topic-cases in Figure 21, this means that the necessary attributes are filled out in a different order.

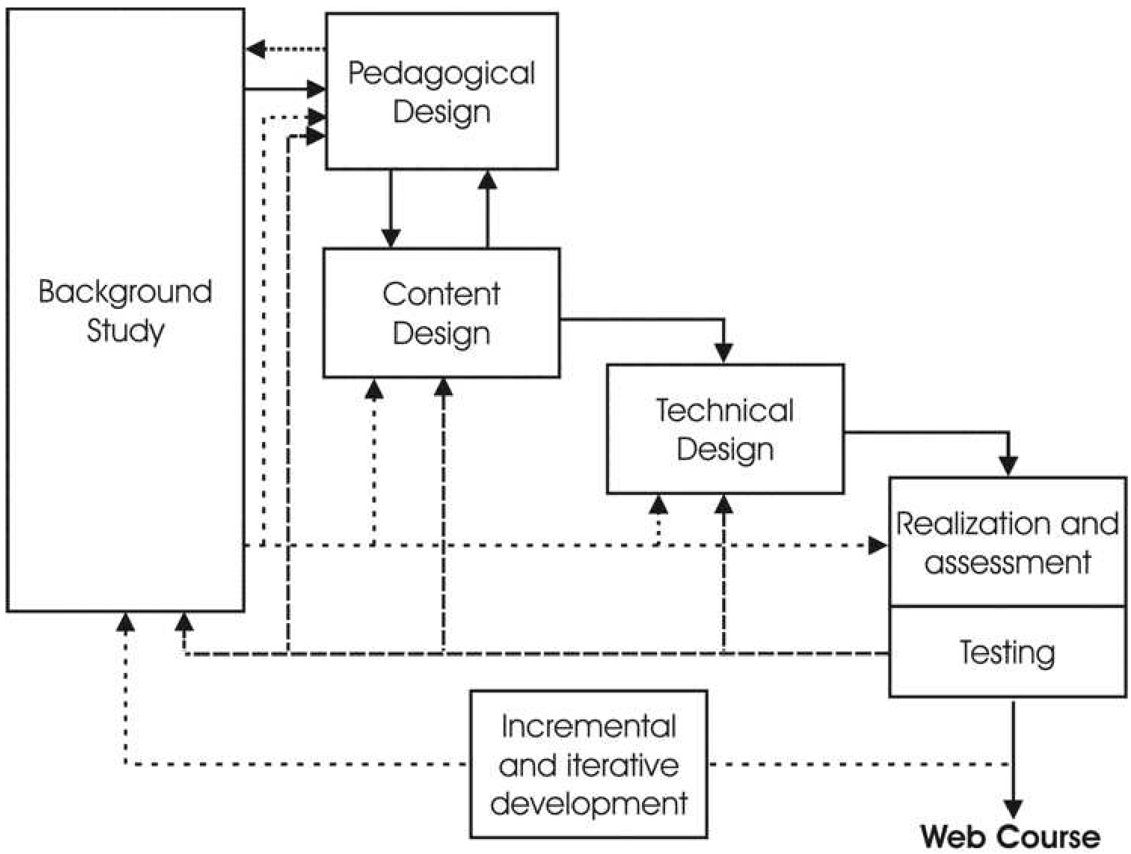

FIGURE 22 Modified design process where strong pedagogical models are driving the whole topic-case driven design process (cf. Figure 16).

6.5 Detailed Technical Design

The presented approach separates the technical design from the pedagogical design, because the pedagogical issues definitely deserve special attention in their own right. During the technical design phase one should make decisions concerning technical issues, like the use of platform, media in use, maintenance, scaling, compatibility, user interface, etc. During this phase, we should also keep usability issues (see Section 4.3) and different standards, e.g., LOM (2002) and ISO 13407:1999 (see Section 4.2) in mind.

At this point, we do not want to commit ourselves to certain technical decisions, because there are again many ways to implement a web course. It is possible to implement the web course based on, e.g., databases, simple HTML web pages, XML or a combination of all of these. There might also be limited tools and software available in different projects. So, how the web course is actually implemented is based on resources, technical infrastructure, and knowledge in use. In the following sections we say a few words about different tasks concerning the technical issues.

6.5.1 Use of platform

Web courses can be implemented as open web pages or using some specific platform. Nowadays there are plenty of different kinds of platforms in use all around the world. The most commonly used platforms are perhaps WebCT (see http://www.webct.com), TopClass (see http://www.wbtsystems.com) and IBM Lotus Learning Space (see http://www.lotus.com). All platforms have different features and different basic rules. They all enable material delivery and communication between individuals, but some of them even support and promote learning.

More precisely, there are usually some tools that support cognitive processes and communication. Platforms also offer certain ways to transmit learning materials, but too often only in the platform's own format. Comparison of existing online course delivery software products is difficult, but many reported comparisons have been made and are available on the Web (see, e.g., http://www.edutools.info/landonline/).

At the University of Jyväskylä most of the educators now use a Finnish platform product called Discendum Optima, which supports web course design through (see http://www.discendum.com/english/index.html):

- A simple and explicit interface
- Ease of use for both students and teachers
- Easy maintenance
- Reusable objects
- Use of external resources (e.g., HTML, Word, PDF)
- Transferable objects in HTML format

Optima supports also the SCORM (Shared Content Object Reference Model; ADL 2005).

6.5.2 Media in use

Depending on the kind of contents and topics on ones own web course it is possible to use different kinds of media for presentations. The typical medium is written text, but often it would be more illustrative to use photos, graphs, tables, animation, videos or even simulations to present current information. This other media is often more informative, but can be much more expensive to produce and maintain. They also have higher technical requirements that might be too hard to reach without an expert in the field. Notice that there are also guidelines for writing for the Web, e.g., by Morkes and Nielsen (1997).

6.5.3 Maintenance, scaling and compatibility

In technical design there are three essential issues that should be considered in order to create web courses with lasting life cycles. These issues are maintenance, scaling, and compatibility. **Maintenance** includes, e.g.:

- Updating date-sensitive materials such as timetables and schedules
- Modernizing the outlook
- Keeping contact information current
- Adding new information or features
- Updating user information

A web course should be easy to maintain: files that need to be updated often or continually could be in the same folder, files should be organized with some systematic regulation, files and web pages should be named in a recognizable way, etc. All of these issues rely on well-structured contentual organization of the material.

Scaling means that the learning system is capable of presenting multiple courses with hundreds of topic-cases for thousands or even tens of thousands of students concurrently and simultaneously. Solutions for this purpose are out of the scope of the present work, but basically they are always based on necessary improvements on the organization of hardware or software platforms and their features.

The contents of the web course should also feature **compatibility** with different platforms and other systems in use. On many occasions one needs to convert parts of the web course or even the whole course into a new environment (or platform). For this reason, it would be, e.g., better to avoid special, platform-dependent formats in the material production.

6.5.4 User interface

Jacob Nielsen has written many books about web usability (e.g., Nielsen 2000). His advice is also useful in web course design. The user interface is the most immediately visible part of web course and users are usually looking at a single page at a time. Especially, when we design a web course *"web pages should be dominated by content"* not by outfits (Nielsen 2000). According to Nielsen (2000) *"navigation is a necessary evil that is not a goal in itself and should be minimized"*. However, users should always know where they are, where they are coming from and where they can go. It is also important for users to know if they have definitely logged out from the system where they logged in with personal user identification.

In this proposal, user interface design is part of the technical design, but it could already start during the Background study phase (especially if one has decided to use some certain learning platform) or after Content design phase when the content is set.

6.5.5 Software Engineering metaphor: Design

During the design phase in software projects the system finds its final structure that guarantees the fulfillment of all requirements. In the Unified Process this phase yields a description regarding how each use-case for the current iteration is going to be realized and what kind of interface the user has for the desired functionality.

6.6 Realization and Assessment

The final **realization** or **implementation** consists of completing the individual topic-cases using the chosen pedagogical and technical solutions. This means that the content is enlarged to the final length and teaching and learning actions are described in detail in connection to the final contents and the media in use.

Assessment is an activity that should be an essential part of the whole development process (and the maintenance phase as well). In the presented approach, the overall assessment (see Figure 23) is divided into three parts:

- Reviews during the development phase
- Assessment of topics and contents after realization
- Assessment of user's required technical, pedagogical and contentual skills

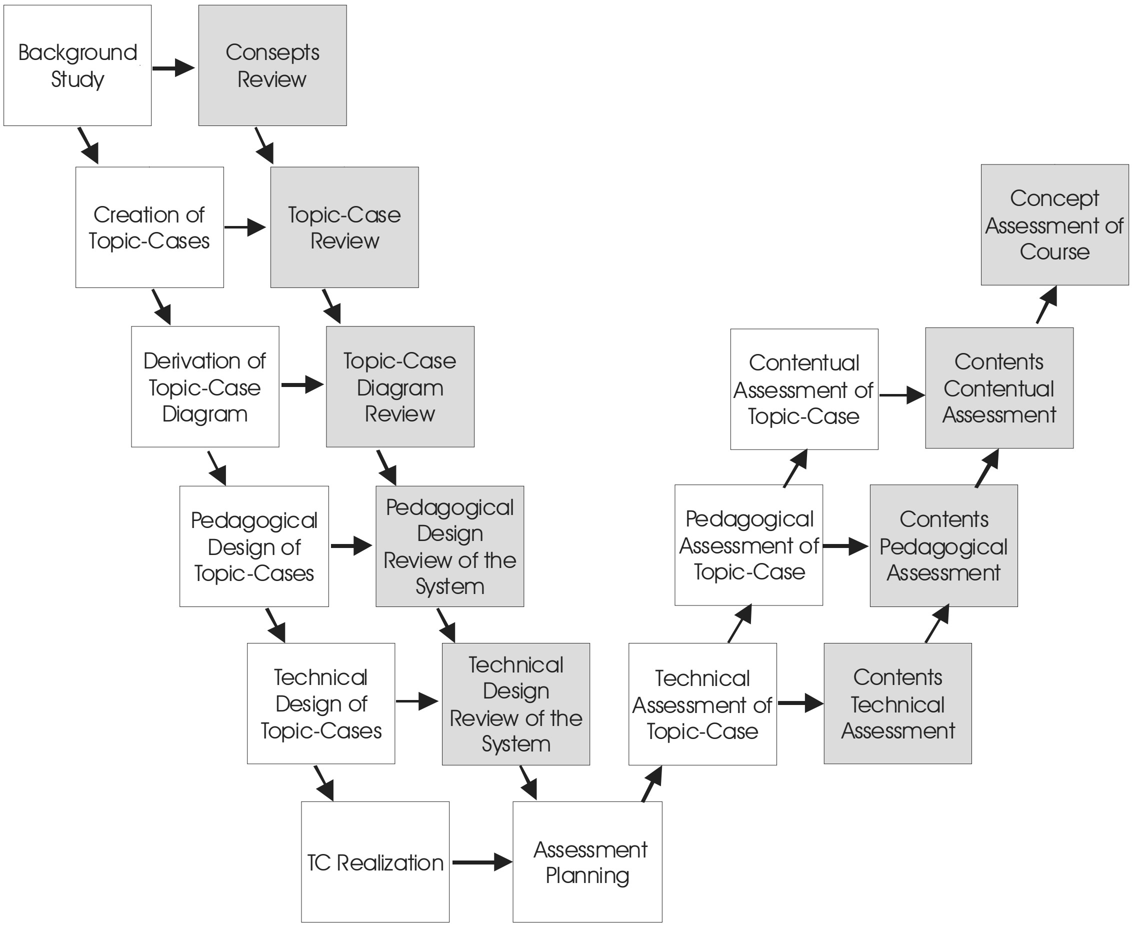

FIGURE 23 Assessment of the web course in accordance with modified V-model of testing

6.6.1 Reviews

Reviews are carried out at the end of each step by developers to ensure that everything has been done as required and to locate as many errors and open problems as possible before proceeding to the next step. For instance, derivation of the topic-case diagram is reviewed by comparing it to the output of the prior step (the creation of topic-cases), and feeding back any discovered mistakes.

6.6.2 Planning and performing of assessment

An actual assessment plan is made after the realization of topics. The assessment plan should cover both the assessment of single topics and the assessment of the whole content of a web course. It should also assess the user's required technical, pedagogical and contentual skills. Assessment is performed by users (students, teachers and technical staff) with real learning, teaching and maintaining assignments.

Assessment of single topics and assessment of the whole content are both divided into three steps: *technical assessment*, *pedagogical assessment* and *contentual assessment*.

Technical assessment. In the technical assessment, technical realization of a single topic is assessed first and then technical functionality of the whole system is considered. Technical assessment is based on five questions (see Nielsen's usability attributes in Section 4.3):

- Is the use of the web course easy to learn?
- Is the web course efficient to use?
- Is the use of the web course easy to remember?
- Does the web course have a low error rate and is it easy to recover from those errors?
- Is the web course pleasant to use?

Pedagogical Assessment. Pedagogical assessment is based on the meaningfulness of learning and pedagogical usability (see Section 4.3) including e.g. the following questions:

- Does the web course support mindful thinking and knowledge presentation?
- Does the web course support communication with others?
- Does the web course offer accessibility to information and construction of personal representations?
- Does the web course support social negotiation and the formation of learning communities?
- Does the web course offer a proper articulation of goals, willful achievements and mindful effort?
- Does the web course support the formation of knowledge building communities?
- Does the web course support the solving of real-world tasks, meaningful and complex problems, constructing situation-specific schemas and defining/interacting with problem space?
- Does the web course support articulation and reflection of new knowledge?

In the presented approach, pedagogical assessment also includes checking that all topic-cases have a pedagogical solution that is consistent with the underlying pedagogical models for the particular web course.

Contentual assessment. The main issues for the contentual assessment are:

- Does the web course include all the topics that were planned at the beginning?

- Are all topics linked properly (logically) together?

In the presented approach this means that all the selected topic-cases have been implemented properly and relationships between topic-cases in the topic-case diagram are consistent with the corresponding plans.

6.6.3 Software Engineering metaphor: Testing

In software engineering projects, there are many different ways to carry out software testing. One of the most used testing methods is the V-model which was first introduced in 1979 by Myers (1979). This model is presented now in a slightly different way, but the basic idea is the same (see Figure 24). In the V-model, *"the testing cycle has been structured to model the development cycle"* (Myers 1979). The key ingredient of this metaphor is the relation of the development of different conceptual phases with their test goals.

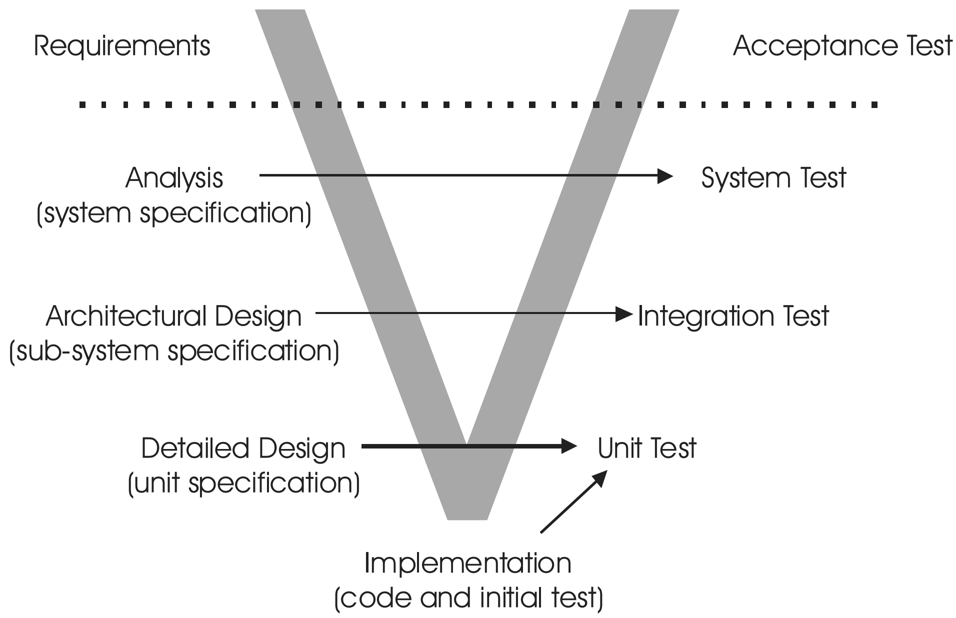

FIGURE 24 V-model of software testing

6.7 Summary of proposed methodology

The proposed approach utilizes metaphors from software engineering (following UP, see Section 3.1) to describe a unified way to design and realize web courses, but this approach is blended together with educational (especially pedagogical) issues. In general, this web course design and realization process contains five phases: *Background study*, *Content design*, *Pedagogical design*, *Technical design*, and *Realization and assessment* (see Figure 16). The presented approach allows incremental and iterative development of the web course (again following UP). Moreover, it can be utilized as a content development mini-project within other similar methods, e.g., by White and Montilva (see Sections 3.3-3.4).

A central task in the first phase, **Background study**, is to define and consider all those issues that affect the feasibility of the planned web course. As a result of this phase one should have a project plan with timetable, resource allocation, financing plan, possible limitations and baselines of the course.

During the second, **content design** phase one designs and documents the basic content of the web course. This phase is divided into two activities: describing topics of a web course on a general level and finding relationships between the individual topics. The method to describe the contents of a web course on a general level is topic-case. Topic-case is a short but structured description of basic lines of the single course topic (or the course itself in the beginning). With topic-cases one first describes the necessary issues that should be treated during the course. Hence, topic-cases form the skeleton of contents of the course (cf. software architecture). Later one adds more features to them, such as pedagogical ideas concerning the realization of topic-cases. The topic-case relations are represented in the topic-case diagram, which defines the basic contentual hierarchy of the web course, serving as a more precise content map.

After the content design phase one has the selected topics for the current iteration that should be augmented with advisable pedagogical activities to support and to describe the teaching and learning of that topic. In the third, **Pedagogical design** phase educators augment selected topics with advisable pedagogical activities. To document the decisions made a presented approach extends the topic-case descriptions by adding a few more attributes that describe in more detail what teachers and students should do and what kind of teaching and learning activities are recommended.

In the fourth, **Technical design** phase one should make decisions concerning technical issues, like the use of platform, media in use, maintenance, scaling, compatibility, user interface.

The fifth and final phase, **Realization and assessment**, consists of completing the individual topic-cases using the chosen pedagogical and technical solutions. This means that the content is enlarged to the final length and teaching and learning actions are described in detail in connection to the final content and the media in use. Assessment is an essential part of the whole development process (and the maintenance phase as well) where acceptability of the web course is evaluated as a whole.

7 CASE STUDY: WEB COURSE DESIGN WITH THE TOPIC-CASE DRIVEN METHODOLOGY

At the Department of Mathematical Information Technology of the University of Jyväskylä students may specialize in computer science teacher education and graduate as computer science teachers. Students will study both computational and educational studies. They will be familiarized with different kinds of educational theories, and how this educational part can be mixed with computer science. They will practice both learning and teaching in different learning environments. Students will also clarify the differences between the traditional classroom environment and the virtual learning environment in both learning and teaching. They will also practice web course design by designing their own web courses for distance or blended learning.

This case study was carried out in a Web Course Design and Implementation Course during the autumn 2004 with a group of graduate students. The course was new and just introduced into the curriculum. There were thirty students who started the course; fourteen distance students who were also at work during the course, and sixteen campus students. Three campus students quit the course at the very beginning because of other demanding studies; so the actual amount of students was twenty seven.

Teaching activities were included on the course during the two-hour lectures twice a week. During some weeks there were only four-hours of exercises related to video photography, sound treatment, web page design, graphics processing, and animating. The course itself utilized the Finnish virtual learning platform called Discendum Optima where all the learning materials were linked. Lectures were streamed as online videos so that the students were able to watch the lectures in real time where ever they were. Lectures were also recorded and linked to the Optima environment so that students were also able to see the lectures later on.

Learning activities on the course were divided into six learning assignments which followed the phases of the topic-case driven approach (see Chapter 6). By performing learning assignments and by following this topic-case driven methodology students designed and implemented their own web courses. The lecturer introduced each learning assignment beforehand and the students were able to get as much guidance as needed during each assignment. Most of the guidance was given by email. A students' performance on these learning assignments is reported in Chapter 7.1.

During the course students wrote learning diaries which contained their feelings, opinions, and descriptions of their own actions during the course. These learning diaries were part of the course evaluation that also included evaluation of activeness, self-evaluation, and peer evaluation of designed web courses. Findings and feedback from the students are reported in more detail in Chapter 7.2. Validity and reliability of the results are discussed in Chapter 7.3.

7.1 Web course design with the topic-case driven methodology

In the following subsections, actions during the different phases of the used methodology are briefly described together with the reporting of the students' performance on learning assignments.

7.1.1 Backgrounds of the web course design

During the first two weeks, students were introduced to the backgrounds of web course design: specification of the web course, clarification on the basic elements of the web course by exploring the web courses found from the Internet, and the introduction to the basics of the web course design and the topic-case driven methodology.

7.1.2 Background study

During the third week, students carried out a background study by defining and considering all those issues that affect the feasibility of the planned web course, e.g. reasons for designing a web course, benefits of a web course compared to a traditional classroom course, use and role of the web, structure of the course, prospective target group or possible students, time and resources in use, basic idea, focus and goals of the course, and copyright and agreement issues in content creation (see Section 6.1). Furthermore, students chose the topic for their own courses, explored different resources (Internet, databases, books, articles, etc.), and created an idea bank from chosen topics as the first learning assignment. Students picked topics as follows (few examples):

- Designing of own web pages
- SQL and database design
- Electronic marketing
- Geometrics in upper grades of Basic Education
- History of Computer Science
- Hardware
- Learning to use Optima
- Word processing
- Learning to use WebCT

7.1.3 Content design

During content design students first reviewed their own idea bank by evaluating different ideas and choosing the most suitable ones for their own web course. Then, they designed and documented the basic content of their web course with topic-cases by describing the necessary issues that should be treated during the course (see Figure 17).

Next, students linked single topic-cases according to preliminary knowledge and pursued learning, and represented these relations in the topic-case diagram that shows which topic-cases are essential to the main concepts of the course and which are prerequisites for other topics. One small example from the course was given in Figure 19.

After two weeks the students had, as the second learning assignment, finished all of the topic-case descriptions with a topic-case diagram that presented the basic content of the web course.

7.1.4 Pedagogical design

During this phase students sized up all the selected topic-cases and tried to find the best pedagogical solution for each case separately. What is the best way to teach or learn this topic? What kind of learning should be supported? What is a suitable pedagogical approach? Would it be better to utilize some other media besides text? What kind of activities (e.g. learning assignments) would support the learning in the best possible way? What is the role of the teacher in these activities? What is the best way to evaluate a students' performance? How previous knowledge from other topic-cases supports learning?

As the third learning assignment, content of the web course and pedagogical activities for each topic were documented with the extended topic-case descriptions (see Section 6.2.1). This took about three weeks. The fourth learning assignment was to produce new kinds of learning materials with video photography or sound treatment into the students own courses.

7.1.5 Technical design

During the technical design students made decisions concerning technical issues. Students could freely choose any platform they wanted (or which supported their plans best) or build the whole course as open web pages. Students freely used different tools and techniques, e.g., HTML, XHTML, Java, Java Script or XML. In spite of having a free hand in the design, students had to keep usability and accessibility issues in mind.

Technical decisions, contents, media elements, and pedagogical solutions were written up on production manuscript as the fifth learning assignment and it was carried out within two weeks.

7.1.6 Realization, testing and assessment

During the last phase students completed the individual topic-cases using the chosen pedagogical and technical solutions. They enlarged the contents and described the teaching and learning actions in connection to the final contents and medium in use. Implementation took about four to five weeks to be completed.

After finishing their implementation, students got another students web course to test and assess as a peer evaluation assignment. This was the sixth learning assignment. We used an eleven page long assessment form to evaluate the different aspects of the realized web courses. From this evaluation students received valuable feedback from their own web course.

7.2 Findings and feedback from the students

Twenty-one students passed the course before the first deadline on December 13th, 2004; eighteen of them with good or excellent grades. Six students (one campus student and five distance students) needed more time to pass the course, mainly because of duties at work. The deadline for them was at the end of February, 2005. Only one campus student had enough time to finish her course from this group. The total amount of successful students was thus 22.

The outcome of the students learning Assessment during the course was based on authentic assessment (see Section 2.5.1). There was both performance assessment and portfolio assessment in use. The students' performance was observed during their work, and learning assignments, learning diaries, self-evaluation, and peer evaluation were included in the portfolio.

Students gave a lot of feedback from the course in their learning diaries. More formal feedback was collected with a feedback questionnaire at the end of the course. Eighteen of the students answered this questionnaire. The feedback is summarized and explained in the following subsections.

7.2.1 General feedback from the course

Most of the students (95%) only had a little experience (Table 5) concerning online learning before taking this Web Course Design and Implementation Course.

TABLE 5 Students' previous experiences on online learning

Previous experience on online learning (N=18)		
None	28%	(5)
A little, I have taken one or two online courses before this one	67%	(12)
A lot, I have passed many online courses already	5%	(1)

Most of the students were satisfied with the technical solutions used at the course (Table 6). Three of the students told that they had some problems with watching recorded lectures – mostly because of the speed of their modem connection. Most of the problems were solved after reminding students that it was also possible to save those videos, e.g., on a memory stick at work or at the university, and transfer the videos to a home computer that way.

TABLE 6 Satisfaction to technical solution of the course experienced by the students

Technical solutions of the course worked well (N=18)		
Totally agree	44%	(8)
Partly agree	33%	(6)
Perhaps	6%	(1)
Partly disagree	17%	(3)
Totally disagree	0%	(0)

Most of the students found enough instructions related to what and when during the course (Table 7). The last student who passed the course had a few problems to find all the instructions, because she had already forgotten where to look. Moreover, most of the students felt that taking the course was flexible enough, especially, as far as timetabling is concerned (Table 8). Some distance students complained that they had trouble following because of other duties.

TABLE 7 Sufficiency of instructions concerning to taking the course

Taking the course were instructed sufficiently (N=18)		
Totally agree	67%	(12)
Partly agree	28%	(5)
Perhaps	0%	(0)
Partly disagree	6%	(1)
Totally disagree	0%	(0)

TABLE 8 Flexibility of taking the course (timetabling)

Taking the course were flexible enough (N=18)		
Totally agree	67%	(12)
Partly agree	17%	(3)
Perhaps	6%	(1)
Partly disagree	11%	(2)
Totally disagree	0%	(0)

According to the students, the goals of the course were defined clearly at the beginning of the course – they all knew what to expect, and what had to be done and when (Table 9). One of the students suggested that there should be more explicit deadlines for learning assignments; he/she felt that those were too flexible. Other student wished that there should have been more instructions for writing a learning diary; students were given a free hand concerning the form of the learning diary.

TABLE 9 Definition of the course goals

Goals of the course were defined clearly at the beginning of the course (N=18)		
Totally agree	89%	(16)
Partly agree	11%	(2)
Perhaps	0%	(0)
Partly disagree	0%	(0)
Totally disagree	0%	(0)

Students felt that the amount of theory and practice was balanced (Table 10). Focus was more on practice, as it was meant to be. Most of the time was spent doing learning assignments which were an essential part of each participants own web course. According to the students, lectures supported the learning assignments well and the design of their own web course. It was also easy to go through the theoretical parts again from the course web site and recorded lectures.

TABLE 10 Balance of theory and practice at the course

Amount of theory and practice at the course were in balance (N=18)		
Totally agree	67%	(12)
Partly agree	33%	(6)
Perhaps	0%	(0)
Partly disagree	0%	(0)
Totally disagree	0%	(0)

Some of the students felt that they did not receive enough guidance during the course and some students were expecting to get more feedback after returning their learning assignments (Table 11). In contrast to this, most of the students felt that they got as much guidance as they needed. One reason for this difference might be the fact that some students asked for more guidance by themselves. They sent emails and asked questions, and got more information that way (even in most cases the teacher sent the answers to other students too). Another reason for these opinions of lack of guidance might be the fact that there were 50% more students taking the course as was first meant to be. Next time the limit for the amount of students taking the course will be stricter.

TABLE 11 Sufficiency of guidance

There were enough guidance available (N=18)		
Totally agree	67%	(12)
Partly agree	22%	(4)
Perhaps	0%	(0)
Partly disagree	11%	(2)
Totally disagree	0%	(0)

Students felt that they learnt many new issues during the course (Table 12). They had not realized how many different matters had to be considered while designing a web course. There were a lot of issues that students would not have taken into account without telling them to do so; they would not have been able to realize how big an influence some issues (e.g., instructions and learning assignments) really have in web course design. Some students told that they were even a little surprised how much they learnt.

TABLE 12 Learning new issues during the course

Learning new issues (N=18)		
Learned a lot	33%	(6)
Learned quite a much	67%	(12)
Already knew these issues before	0%	(0)
Learned just a little	0%	(0)
Learned nothing	0%	(0)

Most of the students were very satisfied with the way the course was organized and carried out (Table 13). Eighty nine percent of students were totally satisfied, and the remaining eleven percent of students were mostly satisfied. Lack of guidance was the biggest reason why all the students were not totally satisfied.

TABLE 13 Satisfaction of students as a whole

Course was satisfying as a whole (N=18)		
Totally agree	89%	(16)
Partly agree	11%	(2)
Perhaps	0%	(0)
Partly disagree	0%	(0)
Totally disagree	0%	(0)

The students liked the way that the course was designed as a web course (Table 14), and according to the students, the course supported each ones' individual learning style.

TABLE 14 Quality of the course as a web course

Course as a web course (N=18)		
Efficient and extremely good	61%	(11)
Better than average web courses, quite good	33%	(6)
Not good or bad, like an average course	6%	(1)
Worst than average course, quite bad	0%	(0)
Meaningless or totally bad	0%	(0)

According to the students, the best parts of the course were the learning assignments, following the process model, and video recorded lectures. The idea to bind learning assignments with the phases was considered excellent. Without this step-by-step procedure the students would not have been able to pass the course so well.

The use of the process model worked very well; it supported the working process well. The students got a lot of new ideas during the whole process. The process model split the work into smaller pieces, and after that designing ones own web course did not feel such a hard task to do - as it did at first. On the other hand, the process model also helped to see the big picture as well.

Streamed online video lectures were of invaluable help especially for distance students. They were able to see and hear all the same things as the students on campus. Video recordings were essential for those who were not always able to participate in lectures. Most of the students watched these videos and even thought they followed the lectures in real time either in distance or in the classroom.

7.2.2 Feedback from the designing process itself

Design was the key word for good results. According to the students, detailed design and following the phasing of the process model helped a great deal to achieve one of the course goals, a well designed self-made web course. The phasing and learning assignments spread the workload equally from September to December.

Designing was sometimes difficult, but diligence and exactness was rewarded in the implementation phase at the latest - many times already during the next step. Students were also able to utilize designs from the previous assignment.

Creation of ones own idea bank was part of the background study, and it was seen as a good base for the participants own design project. Students were able to explore different kinds of implementations found from the Internet, and they got a lot of new ideas. They were also able to refresh their web page design skills.

Before taking this course, most of the students had not realized how many different aspects they needed to consider during the pedagogical design, e.g., different approaches, interaction, communication, guiding, tutoring, design of assignments, authenticity, and different learning styles.

According to most students, technical design was unexpectedly fun and ultimately, by following the previous designs, quite easy. All the students agreed with the traditional dictum: “well designed is half done”. Realization is much easier with good designs.

According to the students, learning assignments related to the design model were illustrative, good and authentic (Table 15). At first some of the students felt that some assignments were irrelevant or unessential for that specific moment. Later on they realized that all of the assignments were useful and related to others, and it was good that they had to consider all these issues in that order. There were good examples which explained what to do, and it was very motivational to get small pieces ready and to see how big the completeness was getting ready piece by piece.

TABLE 15 Perspicuity and authenticity of learning assignments

Learning assignments were illustrative, useful and authentic (N=18)		
Totally agree	61%	(11)
Partly agree	28%	(5)
Perhaps	11%	(2)
Partly disagree	0%	(0)
Totally disagree	0%	(0)

7.2.3 Improvements

Students listed three things in their feedback that need more attention and improvement for the future: the amount of guidance, timing, and timing of interface design. Some distance students complained that they did not get enough guidance during the course. On the other hand, some other distance students explained that they got as much guidance as they needed. One reason might be the fact that a number of the students were simply more active and asked for more guidance spontaneously. There are also individual differences; some students need more guidance than the others. Furthermore, there was a discussion forum for students to ask questions and be able to discuss the design with other students, but only a few of the students occasionally used it.

Some distance students said that the timing was too fast and they would have needed much more time to achieve better results. Students knew at the very beginning of the course how the course was timetabled, but all the distance students were working during the course and most of them also had other studies at the same time, so the timing is mainly the students’ personal timing problem.

Some of the students felt that they would have wanted to design their course interface earlier than they were allowed to do according to the proposed model. This is perhaps because they had some image of their course interface in their minds, but before designing the interface one should be sure what issues are needed on the interface, e.g., links to content, tools, media elements, and learning assignments. After one has drawn the content with a topic-case diagram (see Section 6.3) and decided how to present each topic pedagogically (see Section 6.4) there should be no more changes in the content and all the relationships needed between topics should be there. Furthermore, before writing all the contents up on production manuscript, one can not be sure how much space is needed for text and other media elements, and how to place all these on a computer screen. After doing all this one has all the components available to design the interface. Of course, if one decides at the very beginning, during the Background study, that he/she is going to use some certain learning platform, then this has its' influence on interface design, but still the components needed on the interface are missing.

7.3 Validity and reliability of the results

Results of the case study can be too positive; students enjoyed the course and they created excellent web courses by following the proposed web course design methodology. This positive atmosphere might have had a slightly positive effect on the students' answers. Besides, the size of the student group was relatively small (only 18 students who answered to the questionnaire) and they worked alone or in pairs, so the results could not yet be generalized for bigger design groups. Moreover, the lecturer of the course was involved in inventing the design methodology, so she had a different kind of relationship to this proposed methodology than perhaps another teacher would have had. Furthermore, students were a group of computer science students who had better computational skills than teachers normally have, so there were no problems in that area of competence; they were able to fully concentrate on implementing the content and pedagogical issues. Finally, students were able to get as much guidance during the design process as they needed, this might not (unfortunately) be realistic in real world web course design processes.

7.4 Summary of the case study

The case study was carried out in a Web Course Design and Implementation Course during the autumn 2004 with a group of computer science graduate students. The total amount of participating students was twenty seven; twenty two of them passed the course with good or excellent grades.

During the course students designed their own web or blended courses following the proposed design methodology. Students wrote learning diaries which contained their feelings, opinions, and descriptions of their own actions during the course. In these learning diaries, students also gave a lot of feedback from the course. More formal feedback was collected with a feedback questionnaire at the end of the course. Eighteen of students answered this questionnaire.

Based on the analysis of the results, the case study was successful as a whole. Students designed and implemented excellent web courses and they outperformed right through the design process. According to the students, phasing activities with learning assignments that were based on the phases of the proposed design process was an excellent idea; it made designing easy and even fun. The only improvements that students listed concerned the amount of guidance, timing of the course, and timing of the course interface design. Most of the critique came from distance students who were working during the course. On the other hand, some other distance students told that they got as much guidance as they needed. One reason might be the fact that parts of the students simply were more active and asked for more guidance spontaneously. What comes to timing problems, timing of the course performance was mainly a students' personal timing problem because of simultaneous commitments. Moreover, students would have wanted to do the course interface design earlier than was allowed according to the process model. In practice this is impossible because of the missing components of the interface (see Section 7.2.3).

Results of the case study are slightly too positive. The reasons for this are 1) the common positive atmosphere on the course; students enjoyed the course and they created excellent web courses by following the proposed web course design methodology, 2) relatively small group size and working alone or in pairs; results can not yet be generalized for bigger design groups), 3) the lecturer was involved in creating the design methodology; she had a different kind of relationship to this proposed methodology than perhaps another teacher would have had, 4) students had better computational skills than teachers would normally find, and 5) students were able to get as much guidance during the design process as they needed; this does not happen in real life design processes.

The results of this introduced case study were presented in EDEN 2005 conference (see Hiltunen & Kärkkäinen 2005).

8 CREATING A WEB COURSE REPOSITORY

Usually there are a lot of brilliant topics to affiliate on the web course during the first phase of the web course development process but time and resources are limited. Therefore, one has to make choices between topics and prioritize which topics, forming the core of the web course, are to be implemented first. One can start web course design with a small amount of the most important topics in the first iteration and add more topics during the following iterations. All of this requires good planning, documentation and some kind of standardized procedure to work out, which is supported precisely by the topic-case driven approach presented in this paper.

8.1 Reuse of learning objects

LOM (2002) defines learning objects or small instructional components as, *"any entity – digital or non-digital – that may be used for learning, education, or training"*. The re-use of learning objects means that the same learning object can be used in multiple contexts for multiple purposes.

In the presented approach, all phase deliverables (basic topic-cases, topic-case diagram, extended topic-cases etc.) can be defined as learning objects. More precisely, topic-cases and topic-case diagrams (or parts of them) can be re-used in some other context or in some other web course. In different contexts one can apply different pedagogical and technical solutions, which can be easily changed and/or added into extended topic-case descriptions.

Topic-cases can also be extended, with new attributes if needed, in the identification of re-usable learning objects or to support some other standards and technical constraints.

8.2 Extension of content

The topic-case driven development process allows for the iterative and incremental development of web courses. Once all of these phases have been mastered for the first time and a structure built with relations for smaller contents, one can add new topics into a web course during the next iteration.

First a new project plan has to be made in the background study phase (time and resources have to be considered). Then new topic-case descriptions have to be made from new topics and added into the topic-case diagram (see Figure 25; cf. Figure 19) in the content design phase, and/or those topics from the existing diagram that were left out from the previous iteration can be realized. The chosen topic-cases are then augmented with pedagogical solutions during the pedagogical design phase and fitted into the technical design during the next phase. At the end the whole web course has to be evaluated again.

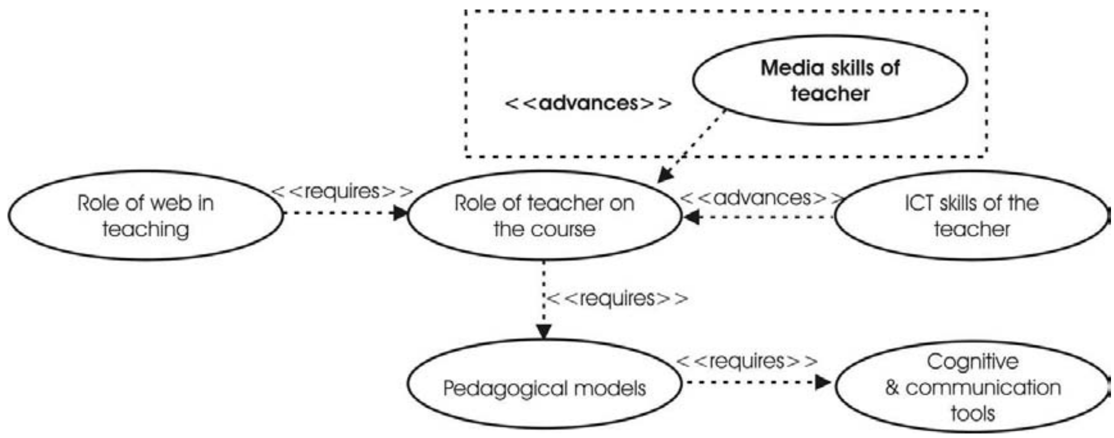

FIGURE 25 Example of extending the content with one new topic-case

8.3 Towards a web course repository

The topic-case driven development process is an iterative and incremental work flow that naturally supports the creation of a web course repository, where the existing topics are related to different courses, through which the overall topic-case diagram (and/or through the overall content map) are contentually related to each other.

After designing and implementing several web courses one has, not only a lot of re-usable topic-cases, but also several solutions for pedagogical and technical issues. From these different objects and solutions one can create a web course repository with re-usable learning objects and pedagogical and technical solutions for the next web courses.

While having difficulties in solving pedagogical or technical issues on web course design, one can explore this web course repository and find solutions or at least develop some new ideas. Old ideas can also be integrated into new web courses. Management of resources is also easier with a repository. A web course repository is also extensible: one can add new topic-cases, pedagogical and technical issues into a repository at any time.

To this end, the topic-case driven approach can be applied, in addition to the web course and repository design, to the training program design. Topic-cases can be used to define an individual course and content maps/general topic-case diagrams can be used to define relationships between different courses. As a result, you are able to produce a pedagogically designed and assessed training program.

9 CONCLUSIONS

In a virtual learning environment the teacher is no longer physically present. Most of the interaction happens through written text without seeing, hearing or touching the people with whom the learners are communicating. Furthermore, most of the new knowledge is created during these interactions between students as well as a student and a teacher. To be able to support and promote this kind of learning, virtual learning environments have to be carefully designed and implemented. Effective planning and quality management are the key issues on the way to a good learning outcome. Effective planning requires some improved methods to follow. Quality management is more of a complex question.

Learning is changing as is teaching and content online, so we should also change the indicators that are used for measuring or evaluating the quality in online learning. Quality as well the effectiveness of an online course is hard to tie down, but **some new quality indicators are suggested in this thesis as a result for first research problem** (see Section 1.1 & Chapter 5).

Proper web course design requires good planning, documentation, and some sort of standardized procedure to be followed. Furthermore, key questions for web course design is how to design granular learning material that benefits from use of the web and how and when to integrate such a (web-) pedagogic into training that enhances learning. Although being important, steps towards a structured method in which to develop web courses, we feel that these two central aspects were not clearly captured in the previous approaches and process models. Our solution, and **answer to the second research problem (see Section 1.1) is new web course design methodology called Topic-case driven web course design methodology**.

The proposed approach utilizes metaphors from software engineering (following Unified Process, see Section 3.1) to describe a unified way to design and realize web courses, but this approach is blended together with educational (especially pedagogical) issues. In general, this web course design and realization process contains five phases: *Background study*, *Content design*, *Pedagogical design*, *Technical design*, and *Realization and assessment* (see Figure 16). The presented approach allows incremental and iterative development of the web course as well (again following the Unified Process).

The proposed methodology was tested with a case study which was carried out in a Web Course Design and Implementation Course during the autumn 2004 with a group of computer science graduate students. Based on the analysis of the results, the case study was successful as a whole. According to students, phasing activities with learning assignments that are based on the phases of the proposed design process was an excellent idea; it made designing easy and even fun. Most of the critique came from distance students who were working during the course.

The case study was executed with a biased and small group: twenty-seven students of computer science teacher education study line. The course was organized for the first time, so first time enthusiasm might have had slightly positive effects on the results. Moreover, working habits of both blended and distance learning groups are based greatly on the teacher's success in organizing and activating students. Furthermore, relatively small group size and working alone or in pairs as well as better computational skills of students leads us to the conclusion that these results can not yet be generalized for bigger design groups. Still, **as the answer to the last research question (see Section 1.1) very encouraging results were obtained concerning the topic-case driven methodology and its utilization in the corresponding course in a bootstrap fashion**.

For future work pedagogical design is an interesting area. There are at least two interesting research areas related to this presented work that came up during this research. The first one is *how to connect pedagogical patterns and scripts into this web course design process*, especially into the topic-cases during the phase of pedagogical design. This first research interest would also support teachers in their design process when they try to find the best possible solutions and activities for their web courses; during their design they could use a web course repository, explore it and find suitable pedagogical solutions (re-usable learning objects) into their courses or at least develop some new ideas.

The second research interest is *how to evaluate the learning outcome*. This contains issues like, how to evaluate the students performance without the need for pondering academic honesty and integrity, and how to get sufficient information on how well learners actually perform. One way to view this research problem could be the designing of learning activities and assignments, because the way these were organized in this case study course served the purpose excellently.

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YHTEENVETO (FINNISH SUMMARY)

Tutkielmassa tarkastellaan verkko-opetuksen laatua ja sen mittaamista, verkkokurssin tuotantoprosessin mallintamista sekä tähän perustuvan menetelmän toimivuutta käytännön verkko-opetuksen suunnittelussa ja toteutuksessa. Näiden tutkimuksen osa-alueiden, joiden merkitys opetusteknologian kehityksessä on viime vuosina voimakkaasti kasvanut, pohjalta tutkielmassa esitellään ns. aihetapauslähtöinen verkkokurssien tuotantoprosessi verkkokurssien suunnittelua ja toteutusta varten. Kehitetty menetelmä perustuu ohjelmistotekniikan metaforien käyttöön muodostettaessa tarvittavia suunnitteluvaiheita, joiden avulla verkkokursseja voidaan toteuttaa selkeästi strukturoitua ja sisältölähtöistä prosessia noudattaen.

Ennen varsinaisen menetelmän esittelyä tutkielmassa kuvataan yleisesti oppimista ja opettamista sekä niiden muuttumista siirryttäessä käyttämään verkko-opetusta. Nämä seikat ovat keskeisessä roolissa verkkokurssien pedagogisessa suunnittelussa, jonka tärkeyden korostaminen osana suunnitteluprosessia on keskeisin ero tutkielmassa esitellyn ja jo olemassa olevien verkkokurssien tuotantomallien välillä. Tutkielmassa esitellään myös lyhyesti eräitä jo olemassa olevia tuotantomalleja ja niiden prosessivaiheita. Tämän jälkeen työssä esitellään opetuksen laatuun vaikuttavia seikkoja, ja kuvataan uusia indikaattoreita opetuksen laadun mittaamiseen ennen varsinaisen aihetapauslähtöisen verkkokurssien tuotantoprosessin esittelyä.

Tutkielmassa esitellään lisäksi tuloksia tapaustutkimuksesta, jossa tietotekniikan aineenopettajankoulutuksen opiskelijat testasivat esiteltyä tuotantoprosessia omien verkkokurssiensa toteutuksessa keväällä 2004 Jyväskylän yliopiston tietotekniikan laitoksella. Tulokset ovat todella rohkaisevia, sillä opiskelijat kokivat, että tuotantoprosessin seuraaminen ja menetelmään kiinteästi kytkettyjen oppimistehtävien tekeminen helpotti oman verkkokurssin suunnittelua ja toteutusta merkittävästi. Tutkielman lopussa tarkastellaan vielä tuotantoprosessin käytön luomia mahdollisuuksia verkkokurssiarkistojen sekä koulutusohjelmien suunnittelussa sekä ylläpidossa.

Avainsanat: verkko-opetus, verkkopedagogiikka, verkko-oppimateriaali, oppimisympäristö, suunnittelu, koulutusteknologia