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Degree Programme in Electrical Engineering

ESSI KANNINEN
LEARNING STYLES AND E-LEARNING
Master of Science Thesis

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In this thesis the field of learning styles in virtual learning environments was studied. The aim of this thesis was to study e-learning methods in virtual learning environment (VLE) and come up precourse and feedback surveys to RGI courses. Another aim was to chart the field of learning styles in virtual learning environments. The use of VLE was studied with questionnaires to students and development ideas were created to enhance teaching in a virtual environment. There were also questionnaires about students' backgrounds and learning preferences. These results can be taken into account when designing adaptive VLEs.

E-learning is learning through an electronic interface that is using VLE. VLE is software which enables the use of different learning tools over the Internet. The platform includes a possibility to share documents, video and audio, forum for discussion and tools for making different activities (e.g., questionnaires and exercises). Adaptive VLE which incorporates learning styles means that students' learning preferences are automatically tracked and the information is used to provide individually tailored courses via a VLE interface.

Learning styles are learners' preferences in learning. There are many models of learning styles. The Visual-Auditory-Kinesthetic (VAK) model is one of the simplest and is based on observation channels vision, hearing and feeling. More profound models are for example Kolb's learning style model and Felder-Silverman learning style model. They take into account more a complex aspect in learning. Almost every learning style model has its own assessment tool in the form of a questionnaire. Quite a lot of criticism has been addressed on learning styles. Minimum standards for any instrument which is to be used to redesign pedagogy are internal consistency, test-retest reliability, construct and predictive validity.

Some actions are proposed to be made in the courses. Three questionnaires to students should be made during a course. Before the course starts there is a questionnaire to gather students' background information and learning preferences. During the course there is a questionnaire where the quality course arrangements and material is questioned. In the end of a course a feedback questionnaire is placed. Focus should be on the students' awareness of learning styles and learning preferences. Everyone takes the ILS test which proposes helpful tips to studying and the most suitable learning objects. In the future questionnaires should be addressed for teachers who use VLE. By asking their behavior in the VLE and giving tips, their use of VLE can be improved and thereby also the quality of the VLE courses. Adaptivity in VLE incorporating learning styles should be studied to detect more accurately students' learning behavior and develop VLE which adapts to students' individual learning styles.

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TERMS AND DEFINITIONS

E-learning	Electronic learning, learning through an electronic interface.
Learning style	How a learner prefers to learn.
Learning theory	Theoretical model of human's learning process.
Virtual learning environment	Software which acts as a platform where learning material is shared.
AHA!	Adaptive Hypermedia for All
ASSIST	Approaches and Study Skills Inventory for Students
BME	Biomedical Engineering
CMS	Course management system
CSI	Cognitive Style Index
EVICAB	The European Virtual Campus in Biomedical Engineering
FSLSM	The Felder-Silverman Learning Style Model
IDEAL	Intelligent Distributed Environment for Active Learning
ILS	The Inventory of Learning Styles by Vermunt
LMS	Learning management system
LSI	The Learning Style Index by Felder
MANIC	Multimedia Asynchronous Networked Individualized Courseware
POP	Personoitu Opiskelijä Portaali (Personified Student Portal)
RGI	Ragnar Granit Institute
TUT	Tampere University of Technology
VAK	Visual-Auditory-Kinesthetic
VAKT	Visual-Auditory-Kinesthetic-Tactile
VLE	Virtual Learning Environment

1. Introduction

This Master of Science Thesis has been made in Ragnar Granit Institute (RGI) which changed its name during the thesis project to Department of Biomedical Engineering. The thesis is part of the Virtual University project and touches on the European Virtual Campus in Biomedical Engineering (EVICAB) project.

Learning is a complex process where student's motivation, teacher, learning material and several other aspects interact with each other. Nowadays the traditional classroom teaching has changed more and more into a virtual environment where different issues about learning has to be taken into account. The basic learning concepts remain the same wherever the studying place is. The students have to be motivated in the learning situation and the material has to be easily at hand. Learning has dramatically changed over recent decades when technical revolution has brought different opportunities to learn via the Internet. (Lahtinen 1997)

Constructivist learning theory is nowadays "the theory" in learning. It emphasizes the learner's experiences in the learning process. Despite that, the studying is still very teacher centered also in the academic level with traditional lessons and practices. This makes students passive. The impression on teaching has changed from teacher-centered to student-centered learning. There the student's role as active learner is emphasized. The learning results depend on students and teacher's activeness and interest in the subject. Student's activeness in the learning process can be activated with alternative learning methods such as group works, discussions and questionnaires. (Korhonen 2004; Verkkotutor 2005)

People differ from each other in the way they prefer to learn. Some like to read things whereas others want to listen. Whatever the best way is it changes between situations and people use multiple learning styles. People differ from each other in learning styles but also in other areas incorporating learning. Some of these areas are motivation, self-confidence and learning speed.

The purpose of this thesis was to make a review on learning styles and how they are taken into account in VLEs. An assessment tool was developed in the form of a questionnaire to get information about students' interest and knowledge on learning styles. The questionnaire was tested in action when it was addressed to students. One aim of this thesis was to develop questionnaires for students about their studying habits and preferences. The surveys were with Moodle's tools. This was studied because of the

interest in knowing better students' backgrounds and how they prefer to learn. The aim was to produce surveys for students which could be addressed at the beginning and end of a course. These surveys were utilized in the EVICAB – project.

In this thesis the use of virtual learning environment (VLE) was charted and the use of it developed. VLE is a platform for learning via internet. It is a program which enables the use of text and multimedia through an electronic interface. There are numbers of VLE's such as Blackboard, Moodle and WebCT. In this thesis the used VLE was Moodle. Moodle is an open source learning environment which offers teachers and students a platform for studying. It can be used for example for sharing material, gathering information and making forum discussions. VLEs are all the time developing into being more versatile and user-friendly. Some VLEs are developed to adapt to students' learning styles automatically, this is discussed in Chapter 4.1.

The thesis consists of 8 chapters. Chapters 2, 3, and 4 deal with background information of the thesis. In Chapter 2 learning in general is discussed with its theories, distance and online learning. Chapter 3 deals with Learning Styles and Chapter 4 introduces Virtual Learning Environments (VLEs). Chapter 5 presents the surveys that were developed in this thesis and in Chapter 6 the results of these surveys are discussed. Discussion about the surveys, the improvement proposals and future work are dealt with in Chapter 7. Chapter 8 concludes the thesis.

2. Learning

2.1. General aspects on learning

Learning is a process where a human absorbs information, memorizes and processes it for further use. There are many things and skills that we learn unconsciously or without further thinking for example riding a bike. But there are also lots of things that we learn consciously and use different strategies to learn it. (Verkkotutor 2005) These strategies we usually use by doing what feels good and right and how we learn best. One can write notes about European history and then memorize them when others prefer to watch a documentary about it memorizing the same learned things.

There is no right way to learn in a specific situation. Everyone has his/her own style on learning which can also vary from one situation to another. Because of the variety of learning theories and styles, one can choose flexibly different strategies and styles in situations so as to use the most efficient one. The better one is aware of his own learning style, the better he can use them to his advantage in learning. (Verkkotutor 2005) People learn differently and there is said to be dissimilar learners. This dissimilarity is due to the fact that learners prefer different learning styles, have different learning motivation and differ from each other in self-confidence. (Vainionpää 2006) Learning styles are dealt with in this thesis in Chapter 3. Motives and motivation originate from targets that are set by the learner. Motivation activates the learner to target-oriented actions which lead to achieving some learning objective. (Salovaara 2005) Self-confidence has an important role in studying and learning. Without a realistic view of oneself and sufficient self-confidence learning is very hard or impossible. (Aho & Laine 2002) The learners can be also dissimilar in their studying pace. Some are comfortable with the existing pace in the university studies but others find it difficult to keep up.

Learning has been very teacher centered in the past centuries. Bransford, Brown and Cocking (2000) emphasize the meaning of learner-centered instruction. Student centered learning doesn't mean giving up teaching all together, but using preconception as a basis when students are consciously and systematically guided towards profound knowing. Bransford considered learner-centered instruction in respect of three essential principals with whom learning environments should be developed. The first principal was information-centricity which means emphasizing students' thoughts and ideas and the substance – what is taught and why. The second principal was evaluation-centricity where

formative evaluation is used to utilize the feedback during the learning process. Students' self-evaluations have a very important role in this principal. The last principal community-centricity guides to break the boundaries of the learning environment and make connections with other communities and specialists. (Bransford et al. 2000.)

2.2. Learning theories

Learning theories and styles observe and define learning with different ways. Learning theory gives a theoretical model of a human's learning process. There are two main theories which have had an impact on learning studies over time. Before the 1960's behaviorism was the leading learning theory. Since then, the constructivist learning theory has influenced most. (Verkkotutor 2005)

The basic idea of behaviorism is that a person learns when reacting to a stimulus. It is a learning concept where learning is defined as a change in behavior. (Oppimiskeskus 2006) Teacher's activity and the learning material itself have been emphasized. Behaviorism has had a great impact on teaching in those days. The essential principles of this learning technology are systematic preplanning, strict definition of the learning goals and the evaluation of learning in relation to the goals. (Salovaara 2004)

Constructivism is based on cognitive psychology which examines man's inner processes like thinking, memory et cetera. In the constructivist learning process the learner constructs information through his own experiences, chooses and interprets it and analyzes it with his former knowledge. The learning is self-regulating and learner-centered. The constructivist principles can be used especially in distance and independent learning. Learning environments are based on constructivist thinking. (Verkkotutor 2005)

The basic idea behind humanistic psychology is the aspiration to holistic research on individuals. It emphasizes human's creativeness and mental growth. Humanistic psychology has had its impact on learning through empiristic learning. It has been used especially in adult education. The humanistic view on learning emphasizes the importance on the learner's experiences. Although the experiences alone are not enough if they are not processed consciously. (Verkkotutor 2005)

Psychologist Howard Gardner developed a theory about human intelligence. He said that there are at least seven types of "intelligences". These are "a set of skills allowing individuals to find and resolve genuine problems that they face."

- Verbal-Linguistic: Ability to use words and language.
- Logical-Mathematical: Capacity for inductive and deductive thinking and reasoning, as well as the use of numbers and the recognition of abstract patterns.
- Visual-Spatial: Ability to visualize objects and spatial dimensions, and create internal images and pictures.
- Body-Kinesthetic: Wisdom of the body and the ability to control physical motion.

- Musical-Rhythmic: Ability to recognize tonal patterns and sounds, as well as sensitivity to rhythms and beats.
- Interpersonal: Capacity for person-to-person communications and relationships.
- Intrapersonal: Spiritual, inner states of being, self-reflection, and awareness.

With school education the first two of the intelligences are emphasized. By widening the teaching to other types, many other students would be served. For example, some students would learn the countries of South America by composing a song about it.

Gardner states that education focuses most on the attention of linguistic and logical-mathematical intelligence and that equal attention should be placed on people with gifts in other intelligences. Gardner suggests that teachers should be trained to present lessons in a wide variety of ways by using for example music, art activities and multimedia. (Gardner 2000)

2.3. Distance learning

Distance learning is learning where student and instructor (teacher) are not in the same place but are in contact with each other through some form of media. There are basically four different generations in distance learning. Already in the 19th century there were distance education and learning as a concept of correspondence education via letters. It had several problems including slowness of feedback and lack of interaction. (Immonen 2000)

In the second generation means of communication were taken into use. Picture and sound came into the learning process through television and radio. The problem in this phase was that the used media was just a distribution channel where students were just passive listeners. The strengths of these medias could be used as a part of distance learning together with other medias. (ibid.)

The problem in the second generation was solved with the third generation's communication technology. It enabled the wanted interaction through phone, email and video conversations. Nowadays we are living in the fourth generation with the online learning concept where information technology is used. The combination of information networks and multimedia has led to generating the term Virtual Learning Environment (VLE). (ibid.)

2.4. Online learning

2.4.1. General aspect on online learning

Online learning is learning which takes place in a network; it could be the Internet or just a school's internal/closed net (Aarnio 2002). Ally (2004) wrote that there are at least the

following synonyms used for online learning: e-learning, Internet learning, distributed learning, networked learning, tele-learning, virtual learning, computer-assisted learning, web-based learning, and distance learning. So it can be said that in online learning the learner is at a distance from the tutor or instructor and the learner uses some form of technology to access the learning materials. (Ally 2004) Online learning can be divided into three classes:

- contact learning supported by the net
- multiform learning in the net
- self studying in the net (Niinimäki 2003)

In the first class some parts of a course can be in the net for example the delivery of learning material and the lectures are given as contact learning. The second class is multiform learning which means using multiple options in learning for example: forum discussions, help from tutors and learning objects (e-books, videos, et cetera). The third class means that the learner studies alone in the net or in a virtual learning environment without outside help.

With online learning, the traditional close learning lessons don't exist but the course material is available in the net for the students. E-learning is a form of distance learning where the teacher has more or less a tutor's role and student's contribution to his learning is greater than in a normal studying situation. Therefore it is considered to be e-learning and not e-teaching. E-learning is more difficult compared to the traditional method for both teacher and student. Courses can be totally in the net or for example the teacher gives lessons normally and just the lecture and exercise material are in the net. Using the virtual learning environment as a part of teaching poses an extra duty for the teacher. Less time is left for updating the material than when the whole course is in the net. This lowers the quality of the course.

According to Pantzar (2003) there are five points of view when considering the suitability of online learning and web courses with constructive learning theory. When the matters to be learned are connected with earlier knowledge and experiences the things to learn should be bonded to the student's own empirical world. Students' capacity for information is limited and therefore new information has to be in proportion to the receiver's capacity. Different interpretations of information bring challenges to learning if the student's interpretations differ largely from other students' points of view. Learning is bound by culture which should be taken into account when organizing the learning environment. A dynamic view of learning leads to the fact that information is changing and recurrent. There are various different versions available of the same learning concept in the learning process and the learners should have good metacognitive skills to be able to select and direct their learning behavior.

The use of web-based learning in engineering education is a natural continuum to development of study methods. Although new technology has been attached to learning the

reason for doing so has not been studied very well. The know-how to use technology among tech-students is high but it doesn't directly mean that it is useful for learning. The whole concept of online learning is so new that the use of the Web and VLE in studying should be taught to obtain the best possible learning level. There are several studies about the Web-based learning but most of them are done in the humanities. The studying process is basically the same in the technology field but the learned matters are completely different.

2.4.2. Self studying in net

Studying in the net doesn't mean just sitting next to a computer "doing nothing". It gives the student the independency of time and place for studying but also the responsibility to gather the needed information instead of the teacher bringing the material into ones lap. Although academy level students are used to academic freedom, studying in the net brings an extra step towards freedom and hence challenge students to a new learning method. This freedom also means the responsibility for students about their own studies. The students' own motivation and awareness on their learning style must be in order to achieve good learning results in e-learning. It is hard to affect student's motivation but for example a handy learning environment and bringing the course content interestingly up have a raising status in student's motivation. The learning environment should support motivation and the course material should be easy to reach to maintain the quality of learning. Here the environment's usability should be considered as an adequate factor for learning.

The teacher has as great importance of a virtual course, if not even greater, as on a contact teaching course. In e-learning the face-to-face contact is missing between the student and the teacher but it shouldn't mean that a contact is missing between them. The student needs support and motivation in his/her studies and the most suitable person for this is the teacher. Questioning and feedback possibilities should be provided for the student in the learning environment. The teacher should also ensure that he responds to students' questions. It could be presupposed that teaching in the net brings more time for the teacher to do other activities and relieve the workload since there is no more lectures or exercises to be given. But putting up a virtual course itself is a time consuming process when all the course material has to be created to the net. On the other hand once the course has been created it doesn't vanish and it is easier in the following years. However the updating of the material and keeping it up to date takes a lot of time. The course has to be updated all the time and the teacher has to participate to the forum discussions. Also revising and evaluating the exercises and other assignments that students have returned takes time.

2.4.3. Strengths and weaknesses on online learning

One strength of online learning is that the students can access the e-learning material anywhere, anytime and at any pace they want. Space commitment is not relevant and students can freely study whenever they have time. The coordinator of an e-course can be for example in Finland and the participants all around the world. Everything needed to study is on the Internet and the material and other participants of the course can be accessed via the web.

When studying online, resources and ideas are shared between students themselves and between students and instructor. This dynamic interaction is one of the greatest traits in e-learning. High quality dialog can be attained using asynchronous discussion structures (for example forums), because participants have more time to consider their responses than in the face-to-face conversation. Interactivity is often self-evidently connected to working on the net. To bring about target-oriented collaborative learning is a major issue in online learning. It is a problematic issue and hard to realize and therefore an essential problem in online learning. What would be the key to reciprocal learning process? The way the students see learning should change so that other students are seen also as a source of information and comprehension. (Illinois Strength and Weaknesses 2006)

Online learning is based on technology. Nowadays technology plays an enormous part in the western countries and therefore online learning can be easily adapted to our society. In the less developed countries computers and internet connections are not everyday life and even in the developed countries not everyone has access to the Internet and online learning. Even if one has the possibility to participate an online course, the possession of needed computer skills can be too limited. Also the limitations of the technology itself can hinder the learning. The technology is not 100% reliable. (ibid.)

Online learning brings a lot of responsibilities to students. Everyone is of course responsible for his own learning but in e-learning there are no authorities and strict schedules when and how to work. The facilitator of an online course must be capable to compensate the lack of physical presence with other methods to be accessible. Otherwise alienation between students and instructor can occur.

The online environment itself can limit the levels of synergy. With large groups (more than 20 people) the dialog becomes somewhat limited. The virtual environment is not suitable to all kinds of education, for example public speaking, surgery or sports. Putting up an online curriculum and learning environment one can not directly transfer the old courses into virtual ones to obtain a high quality e-course. The need of qualified professionals to develop distance education programs is often overlooked. (ibid.)

2.4.4. Web course

A web course, also known as an online course is a course which is delivered to students through the web. A course can be text based or have computer-mediated enhancements or is fully designed for web setting. (Caplan 2004) General tasks and objectives for teaching are defined in Fleming's (1987) topology. It divides them into six categories: attention, perception and recall, organization and sequencing, instruction and feedback, learning participation, higher order thinking and concept formation. (Fahy 2004)

Criteria on a web course

According to Nevgi and Tirri (2003) there are several characteristics for a quality web course. First, the course needs to have a clear objective and structure. Also the learning material has to be clear, versatile, logical and interesting. It is important that the course forms a clear and compact ensemble and the format of the course is clear, easy on the eye and also esthetic. Clear instructions make it easier for students to obey them. A quality web course attracts discussion and the discussion area is functional. This way interaction between students can be achieved. Of course communication between student and teacher is important and web course should also provide that aspect. Picture and audio material should be at hand and have enough links to resources.

There are also some characteristics related to the student and the studying. The student is motivated as well as possible and student's learning style is supported (text, audio, video). The teacher should be motivating and supporting and the learning environment should be clear, interesting, functional and easy to use. It is also important that teaching aids are suitable for the course and the learning material is up-to-date and of good quality. One criterion is that the course is easily available to students, regardless of time. (Nevgi & Tirri 2003)

Other criteria for good quality web course are that the information technique is functional, even for a large number of people. If the learning isn't functioning properly, students can not use it to its full capacity. Feedback from the teacher is important; it has to be rapid and relevant. By getting proper feedback students can revise their learning well enough and progress their learning. One important thing is that the hypertext is clear, meaning that the course pages shouldn't be too "heavy". It should not have too many layers, so it is simple to use. Guidance should be also clear and easy to find. (ibid.)

2.4.5. Teaching, instructing and evaluation in online learning

In online learning teaching and instructing can be used as synonyms because the interaction is often delayed and happens through an interface. Routines related to teaching are made

mainly beforehand in an online environment and many traditional teacher's tasks and roles are replaced by hypermedia objects and communication tools. (Mannisenmäki 2004)

Tella et al. (2001) present five important roles for the teacher in an online learning environment. The teacher's role as a motivator is emphasized because the online environment lacks the typical motivation aspects of the traditional learning. To maintain the motivation the teacher should provide: enough challenging tasks, current and quality learning material, versatile interactions and social contacts. The teacher is also a networker who creates communication and expert networks demanded by learning. One important role is an organizer. S/he organizes the didactic challenges according to learning such as the used tools and applications. A communicator is one role for the teacher in the online environment. Communication in online learning is done via e-mails, chat groups, forums and the Internet pages. The teacher should actively follow and guide the students and act as a tutor because there is no chance of face-to-face communication. Guiding is very important in the online learning and it is based on discussion.

Online learning demands strong self-steering, motivation, and empirical atmosphere. Therefore new ways of acting are needed in evaluation. How can learning be evaluated versatily and comprehensively when the teacher and the student may never meet? Practices on evaluation should be in the same line with other actions in an online course. In the online learning it is possible to use various evaluation methods by using information from forum discussions, exercises, quizzes, feedback questionnaires, learning diaries and portfolios. (Tella 2001; Vainionpää 2006) One form of evaluation is a web-exam. A web-exam has been used in the LTT-6100 Bioelectromagnetism course with good results. Self-evaluation is a practical tool and also peer evaluation can be used where students evaluate each other.

2.5. Virtual curriculum on the Internet

Web-based learning offers a variety of choices to use technology not only inside one university or even one country but also between other countries all over the world. It gives a great opportunity to bring and share information and knowledge. One example on this kind of multicultural change of knowledge is a project funded by European Commission: European Virtual Campus for Biomedical Engineering (EVICAB). The project lasted two years from the beginning of 2006 to the end of 2007. This thesis has been part of the EVICAB project. The same kinds of questionnaires were developed for that project as was done in the thesis.

Because the field of BME is multidisciplinary, it has a large number of sub-specialties and it is developing fast, it is difficult for any university to produce high quality and up-to-date education material by themselves. By providing and sharing courses of the Internet this aspect of BME can be solved. The objective in the EVICAB project is to

develop, build up and evaluate sustainable, dynamic solutions for virtual mobility and e-learning. The goal is that the institutes of universities that participate in the project have the opportunity to use courses offered by the other institutes. A framework for sustainable Internet-based virtual biomedical engineering curriculum was developed, building on existing expertise in the substance and e-learning technology. The Moodle platform created for the project can be found at the following web-site: <http://www.moodle.fi/evicab/moodle>. One objective of the project is that the courses will be free of charge. The courses are updated and maintained by the universities that produced them. (EVICAB RGI)

The project included partners from five different European countries; Finland, Estonia, Lithuania, Sweden, and Czech Republic. The partners in the EVICAB project were:

- Tampere University of Technology – Ragnar Granit Institute
- Tallinn University of Technology - Biomedical Engineering Centre
- Kaunas University of Technology - Biomedical Engineering Institute
- Linköping University Department of Biomedical Engineering
- Brno University of Technology - Department of Biomedical Engineering and
- Mediamasteri Group.

The partner universities offer BME courses to EVICAB which are accepted by the Steering Group. Courses may also be provided by co-operating universities outside the consortium. The courses must be recognized by at least one university to be used in Bachelor/Master/PhD –studies. Partner universities can take courses from EVICAB to their own Biomedical Engineering program. Courses may also be taken by co-operating universities outside the consortium. (ibid.)

The Moodle site created to this project is a platform for the students to study in virtual environment but the full EVICAB courses are also available in open web-pages. There are seven courses in the curriculum that are recognized by some of the partner universities:

- Bioelectromagnetism by Jaakko Malmivuo
- Computational Modeling of Cardiovascular System by Frank Sachse
- Transcranial Magnetic Stimulation by Risto Ilmoniemi
- Bio-optics by Göran Salerud
- Introduction to Biomedical Signal Analysis by Jiri Jan
- Biomedical Signal Analysis; Biomedical Image Analysis by Rangaraj M. Rangayyan

The courses include e-books, videos, slide shows, exercises, and web-exam. It is possible to download the lecture videos as m4v-files to computer using iTunes, to portable device iPod or as 3gp-files to media phone.

3. Learning styles

3.1. Introduction to learning styles

Learning styles are based on the research results of cognitive psychology about processing information, active learning and the structure of information. The learners prefer intuitively some forms of information and a specific way of action over others when reaching quality learning. The division of learning styles is based on that. (Vainionpää 2006)

Learning styles are not strict and do not outline each other. It means that a person might prefer some learning style over others but also use aspects of other styles. The learners possess several learning styles and can mix them together to obtain the most suitable combination for each learning event.

One important aspect is how students recognize their learning style and what impact it has on learning. As Coffield (2004) says the knowledge of learning styles can be used to increase students' self-awareness and metacognition of their strengths and weaknesses as learners. Merrill (2000) argues that most of the students are unaware of their learning styles and if they are left alone with learning style questionnaires, they are most unlikely to start learning in new ways. Coffield points out that for those students who lack the confidence about their learning it can be motivating to find out new ways to describe and explore their behavior as learners. The quality of motivation depends on how experienced the students are to use the learning style instruments and of the feedback of the instrument.

3.2. Learning style questionnaires

Almost every learning style model has its own assessment tool in a form of a questionnaire. These learning style inventories include various amounts of questions about personality, study attitude and behavior. Learning style inventories help people to be more aware of their learning style but it has to take into account that they have also limitations. One should not label his own style too narrowly.

Coffield, Moseley, Hall and Ecclestone (2004) list 71 different learning styles in their review on Learning style and pedagogy in post-16 learning. 60 of the styles have their own measurement tool. Coffield et al. divided learning styles in five groups:

- Genetic and other constitutionally based learning styles and preferences including the four modalities Visual-Auditory-Kinesthetic-Tactile (VAKT)

- Cognitive structure
- Stable personality type
- Flexibly stable learning preferences
- Learning approaches and strategies

The division of learning styles in the previous five families is shown in Table 3.1.

TABLE 3.1. Families of learning styles (Coffield et al. 2004).

Families of learning styles

Genetic and other constitutionally based learning styles and preferences including the four modalities VAKT		
<i>Author(s)</i>	<i>Assessment tool</i>	<i>Year introduced</i>
Dunn and Dunn	Learning Style Questionnaire (LSQ)	1979
	Learning Style Inventory (LSI)	1975
	Building Excellence Survey (BES)	2003
Gregorc	Gregorc Mind Styles Delienator (MSD)	1977
Cognitive structure		
Riding	Cognitive Styles Analysis (CSA)	1991
Stable personality type		
Apter	Motivational Style Profile (MSP)	1998
Jackson	Learning Style Profiler (LSP)	2002
Myers-Briggs	Myers-Briggs Type Indicator (MBTI)	1962
Flexibly stable learning preferences		
Allison and Hayes	Cognitive Style Index (CSI)	1996
Herrmann	Brain Dominance Instrument (HBDI)	1995
Honey and Mumford	Learning Styles Questionnaire (LSQ)	1982
Felder and Silverman	Index of Learning Styles (ILS)	1996
Kolb	Learning Style Inventory (LSI)	1976
	LSI Version 3	1999
Learning approaches and strategies		
Entwistle	Approaches to Study Inventory (ASI)	1979
	Revised Approaches to Study Inventory (RASI)	1995
	Approaches and Study Skills Inventory for Students (ASSIST)	2000
Sternberg	Thinking Styles	1998
Vermunt	Inventory of Learning Styles (ILS)	1996

Learning style questionnaires include various amounts of questions about personality, study attitude and behavior. Learning style inventories help people to be more aware of their learning style but it has to take into account that they also have limitations. One should not label his own style too narrowly. The Myers-Briggs Type Indicator (MBTI) is a series of forced-choice questions. In the questionnaires can be for example pairs of statements and the students are asked to indicate their degree of agreement with either statements, or no

preference, using a 5 point scale. In some of the questionnaires the students are asked to rate their agreement or disagreement to these questions on a 3-point or a 5-point Likert scales. The Kolb Learning Style Inventory (LSI) has a forced-choice ranking method to assess students' preferred modes of learning. The students complete twelve sentences about their preferred way of learning. Each sentence has four endings and the individuals are asked to rank the endings according to what best describes how they learn (4 = most like you; 1 = least like you). In Felder's Index of Learning Style (ILS) learners' personal preferences to each dimension are expressed with values between +11 to -11 per dimension. This range comes from the 11 questions that are posed for each dimension. (Graf 2007)

Coffield's review examined 13 learning style models where each model was examined for evidence, provided by independent researchers, that the instrument could demonstrate both internal consistency and test-retest reliability and construct and predictive validity which are the minimum standards for any instrument which is to be used to redesign pedagogy. Only three of the models: Allison and Hayes, Apter, and Vermunt came close to meeting these criteria. Entwistle, Herrmann and Myers-Briggs met two of the four criteria. The Jackson model is so new that no independent evaluations have been carried out so far. The remaining six models failed to meet the criteria. The review led to the conclusion that they are not all alike nor of equal worth and it matters fundamentally which instrument is chosen. The evaluation showed that "*some of the best known and widely used instruments have such serious weaknesses (for example low reliability, poor validity and negligible impact on pedagogy) that we recommend that their use in research and in practice should be discontinued.*" (Coffield et al. 2004, p. 138.) However some of the models were appraised as promising with certain reservations.

Cognitive Style Index (CSI) on Allison and Hayes had the best psychometric credentials. The model was designed to be used in organisational and business contexts, and is less relevant for use with students than by teachers and managers. Entwistle's Approaches and Study Skills Inventory for Students (ASSIST) is "an important aid for course, curriculum and assessment design, including study skills support. It is widely used in universities for staff development and discussion about learning and course design." Coffield suggests that Vermunt's Inventory of Learning Styles (ILS) can be "safely used in higher education, both to assess approaches to learning reliably and validly, and to discuss with students changes in learning and teaching." (Coffield et al. 2004)

3.3. Learning style models

3.3.1. VAK learning style model

There are many different kinds of learning style models based on different aspects. In this thesis four of them will be discussed. One model concentrates on human observation channels; vision, hearing and feeling. It is called the Visual-Auditory-Kinesthetic (VAK) model. Probably the most well known model is the Kolb's learning style model. The Honey and Mumford's learning style model and The Felder-Silverman model are also briefly introduced.

The observation channel model or in other words the Visual-Auditory-Kinesthetic (VAK) model bases on the basic observation channels of human. The learning styles are divided into four categories; visual (verbal), visual (non-verbal), auditory and kinesthetic. Sometimes the word tactile is connected to the kinesthetic category changing the model name into Visual-Auditory-Kinesthetic-Tactile (VAKT). The VAK model is not a learning style in a way that the other learning style models are. It is not developed by any specific person or persons. The model is anyway a base for several learning style models including for example the Dunn and Dunn learning style model and the Gregorc's Mind Styles Model and Style Delineator. (Työssäoppiii 2006; Illinois Learning Styles 2006)

Learners with visual learning style learn best using their eye sight. Seeing and reading are described to be important for visual learners. For example pictures, Tables, demonstrations, handouts, and mind maps are very useful for them. Especially lecture notes, textbooks and other written text is the most useful way of learning. It is easy to add those things in the learning environment and therefore it is easy to visually learning students to use and study in virtual environment. Thematic entities are important to this kind of learners. (ibid.)

The students who learn best through hearing (aurally) can find virtual learning useful if there are video clips, virtual lectures, and video conferences because listening and speaking are important for auditory learners. The clips can also be easily added to the environment. The learners with auditory learning style like to hear detailed directions. They learn things one at a time. Auditory learners benefit from listening to lectures and participating in discussions. (ibid.)

Kinesthetic learners learn best through feeling and experimenting. They prefer laboratory sessions or field trips over classroom lectures. These learners like to be involved with physical experiences; touching, feeling, holding, doing, and practical hands-on experiences. Therefore the virtual learning environment brings a lot of challenge to their learning. In the learning process some kind of virtual models can be useful for them where one can see how things work. (ibid.)

TABLE 3.2. VAK learning styles in e-learning (Filppula 2006).

Learning style	Prefers in learning	Recommended e-learning activity
Visual, verbal	Text	E-books, lecture notes, articles.
Visual, non-verbal	Graphics, Tables	Figures, charts, Tables, maps, videos, animations.
Auditory	Sound	Group works, virtual lectures, sound samples, video conferences.
Kinesthetic	Practical related things	3D-models, hands-on tests with specific programs.

Table 3.2 shows how the VAK learning styles are to taken in to account in e-learning. For visual learners with verbal aspect Filppula (2006) suggests e-books, lecture notes and articles. Figures, charts, Tables, maps, videos and animations are recommended for the visual learners with non-verbal aspect in learning. The auditory learners prefer hearing in learning and therefore group work, virtual lectures, sound samples and conferences are helpful to them in the e-learning environment. For the kinesthetic learners e-learning gives the greatest amount of challenges compared to other styles because there are no practical ways to perform things in VLE. Anyway some e-learning activities are recommended for them such as 3-D-models and hands-on tests with specific programs.

3.3.2. Kolb's learning style model

David Kolb developed his learning style model over years basing it on the research on many others, for example Rogers, Jung, and Piaget. He published it in a book 'Experiential Learning: Experience As The Source Of Learning And Development' in 1984. Kolb's experiential learning theory (ELT), and Kolb's learning styles inventory (LSI). (Businessballs)

Kolb's learning theory includes four different learning styles, which are based on a four-stage learning cycle. The learning cycle stages are:

- Concrete Experience (CE) - feeling
- Reflective Observation (RO) - watching
- Abstract Conceptualization (AC) - thinking
- Active Experimentation (AE) - doing

Figure 3.1 shows a flow chart on Kolb's learning cycles and styles. Kolb says that concrete experiences lead to observations and reflections. These reflections are absorbed and translated into abstract concepts with implications for action, which a person can actively test and experiment. This enables creation of new experiences and starts a new cycle.

Ideally this process represents a learning cycle where all the bases on learning; experiencing, reflecting, thinking and acting are treated. (Businessballs) The learning styles definitions are representations of the combination of two preferred styles (see the abbreviations after the cycle stages):

- Diverging (CE/RO)
- Assimilating (AC/RO)
- Converging (AC/AE)
- Accommodating (CE/AE) (Businessballs)

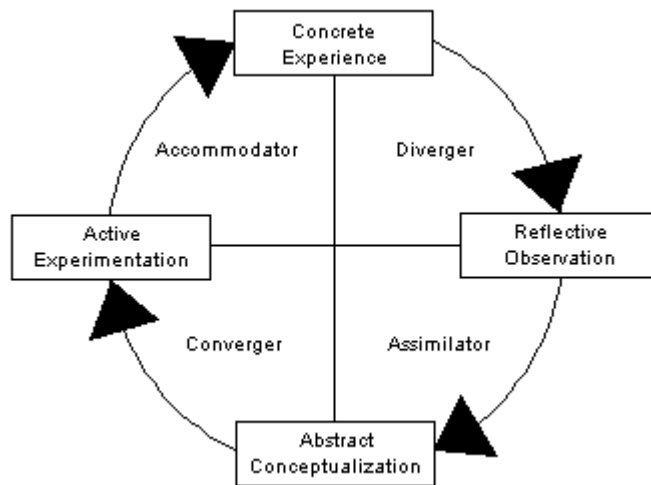


FIGURE 3.1. Flow chart on Kolb's learning styles (Pijlzieber).

The diverging learning style is learning through feeling and watching. The word diverge means break up or differ from something (English-Finnish General Dictionary 1997). These people prefer to watch rather than do. They are best at viewing concrete situations from several different viewpoints. They prefer working in groups, receive personal feedback, gather information and use imagination to solve problems. (Smith 2001)

The assimilating learning style combines watching and thinking as ways to learn. The word, assimilate, means absorbing and translating (English-Finnish General Dictionary 1997). This can mean that the assimilators prefer clear explanations rather than practical opportunity. For assimilators ideas and concepts are more important than people. They want clear explanations and tend to like logically sounding theories over ones that are based on practical value. These kinds of learners prefer readings, lectures and exploring analytical models. (Smith 2001)

The converging learning style is learning by doing and thinking. The word converge means to get closer to something (English-Finnish General Dictionary 1997). It can be seen as the convergers like to combine ideas and practice closer together. People with

converging learning style like to find out solutions for practical issues. They prefer technical tasks, and are less concerned with people and social or interpersonal issues. Convergents like to experiment with new ideas, to simulate and to work with practical applications. (Smith 2001)

The accommodating learning style combines doing and feeling as ways to learn. The word accommodation means adaptability (English-Finnish General Dictionary 1997) which can mean that the accommodators like to adapt the learned things into practice. Learners who prefer accommodating learning style like to do things concretely. The Accommodating learning style relies on intuition rather than logic. These learners take a practical and experiential approach to learned material. They prefer to work in teams to complete tasks. (Smith 2001)

3.3.3. Honey and Mumford's learning style model

A learning style model developed by Honey and Mumford in 1982 is based on Kolb's work but is somewhat different. It includes four key stages of learning styles:

- Activist
- Reflector
- Theorist and
- Pragmatist.

They are often presented as the Kolb's learning styles although they differ a little. Activists enjoy new ideas and tasks and like to be very active in the learning process. Activists learn best when they are involved in new experiences, problems and opportunities. They like to work in groups, work with tasks and educational games. Listening to lectures or reading and writing on their own, hinder the activists learning. They don't like to follow precise instruction or strict schedules. (Campaign For Learning 2006)

Reflectors are more drawn back than the activist. They prefer standing aside and think what is happening. They learn best by observing someone else, collecting information about it and going through what was learned. They like to produce analyses and reports. Reflectors don't like to be leaders or do things unprepared and with tight deadlines. (ibid.)

Theorists prefer analytical and rational thinking over subjectivity and emotions. They like complex problems where they can use their skills and knowledge. Structured situations, interesting ideas and concepts are things which theorists like in the learning process. Theorists learn less in situations where emotions are emphasized or activity is unstructured or briefing is poor. (ibid.)

Pragmatists are the ones who prefer hands on doing over theory. They like that learning tasks are related to their present or future job. Pragmatists are down-to-earth who learn less when there is no benefit to achieve or no guidelines to do the job. (ibid.)

The Honey and Mumford learning style stages and the Kolb's learning styles are very similar. Here is correspondence between them:

- Activist = Accommodating
- Reflector = Diverging
- Theorist = Assimilating
- Pragmatist = Converging (Businessballs)

Table 3.3 presents e-learning activities for different learning styles according to Filppula (2006). Activists need interaction between other students in e-learning environment and therefore group works and real-time conversations are recommended for them. E-books and forum discussions are recommended for reflectors because they like well outlined lectures and systematic instructions.

TABLE 3.3. Kolb's learning styles in e-learning (Filppula 2006).

Learning style	Needs in e-learning	Recommended e-learning activity
Activist	Interaction between other students, free form exploration and observation, no strict schedules.	Group works, experimental problem-solving, real-time conversation.
Reflector	Organized studying methods, well outlined lectures, systematic instructions.	E-books, forum conversations.
Theorist	Traditional learning, clearly defined goals, well prepared exercises, tests measuring learning.	Assignments: case study or logical cause-effect, problems and quizzes during the course.
Pragmatist	Experimental possibilities.	Practical exercises, real-time conversation.

Theorist learners like traditional learning and clearly defined goals. They are recommended by logical cause-effect assignments and quizzes during the course. For pragmatists practical exercises and real-time discussions are recommended in e-learning because they like practical issues.

Website organization according to Kolb's model

In the website of University of Minnesota innovative teaching is a list of how to organize a website according to Kolb's learning styles model. The website should provide resources that cater to all four modes for the various units, such as: practicum guides/practical links for help with practicum, flash concept maps, lecture notes, practice quizzes that provide

feedback, links to video clips, discussion board with reflective questions, some of which can be optional. The website should also include assignments such as:

- Active planning and creating such as projects and lesson plans.
- Optional ones could be posted on the Discussion Board for discussion and sharing of ideas. Maybe offer extra credit for high quality projects.
- Watching activities such as video clips and personal stories.
- Thinking activities such as readings and accompanying questions (like a reading guide).
- Feeling activities such as discussion board topics that involve reacting to an experience. (Morris 2006)

There should also be a link on the main page that will bring students to a learning styles course organization page. On this page, the course resources are organized based on the modes. The resources are listed with different colored links based on the modes that they use. The students are asked to reflect on their different assignments in the discussion board:

- How can this assignment help me to construct knowledge?
- How might an assignment like this help my future students?
- On what kind of learner is this assignment the most supportive?
- How can this assignment help me to practice different ways of learning? (Morris 2006)

This kind of website organization could help the students with different learning styles to study more effectively because learning objects suiting their learning styles are available. The students can find the resources according to their learning style easier and quicker.

3.3.4. Felder-Silverman model

The Felder-Silverman learning style model (FSLSM) was created by Richard Felder and Linda Silverman in 1988. It focuses on aspects of learning styles on engineering students. The model had five dimensions in the original version but was changed to four when one dimension was deleted. The learning style dimensions according to Felder are:

- sensory/intuitive
- visual/verbal
- active/reflective
- sequential/global.

Sensory learners like learning facts and solving problems with known methods while intuitives prefer discovering possibilities. Active learners like to try things out or do something active. Reflective learners prefer thinking about things on their own. Sequential learners learn in small steps when global learners understand things in large steps. (Felder 2002)

TABLE 3.4. Recommended activities in learning VLE according to the FSLSM (Graf 2007).

Learning style	Recommendations in learning and VLE
Active	Linear text, general vision maps, chat, forum and emails. Navigation based on arrows (back and forward), providing printings. Guessing possible questions and answering them with other students.
Reflective	Lesson objectives, case studies, conceptual maps and slide shows based on text as well as linear text. Online help and email. Opportunity to write short summaries about the already learned material and emphasising activities where learners can watch and listen.
Sensing	Facts, concrete material and data, hands-on activities, and practical material. Applying theory into practice, relating information to the real world. Slideshows, hypertext, a response system, a digital library, media clips, graphics, audio objects, case studies, conceptual maps, multimedia slideshows, graphics, digital movies, audio objects, and linear text.
Intuitive	Concepts and theories. Letting the students discover possibilities, fostering their creativity and innovative talent, asking them for interpretations that link data and facts. Lesson objectives, conceptual maps, text and multimedia based slideshows, graphics, digital movies, audio objects, and linear text.
Visual	Graphics, tables, flow charts, images, videos, demonstrations, conceptual maps, colour notes with highlighters, slides with multimedia and animations. Slideshows, a digital library, case studies and a focus on synthesis.
Verbal	Text-based material, also including audio objects, lesson objectives, hypertext, slideshows, a digital library, conceptual maps, and hypertext. Opportunity to write summaries about the learning material, work in groups and discuss and lecture learning.
Sequential	Guidance and having a predefined learning path.
Global	Slideshows, a response system, media objects, and open course structure.

Table 3.4 shows the recommended activities in VLE according to the FSLSM. Linear texts, chats, and forums are recommended for active learners because they like to do something active and to learn in groups. Slideshows based on text and online help are recommended for the reflective learners because they prefer thinking and reflecting on the learning material. Learners with sensing learning style find slideshows, hypertext, and a response system helpful in e-learning because they like to learn concrete material. On the contrary intuitive learners prefer learning abstract material, concepts and theories. They need conceptual maps and linear text when they are studying in a VLE. Graphics, Tables, and animations are recommended for the learners with visual learning style. Verbal learners prefer text over images in learning and in VLE they are recommended with text-based material, digital library, hypertext, and the opportunity to write summaries about the learning material. Sequential learners are recommended with guidance and predefined learning paths in the VLE because they like studying in linear steps. Global learners need

slideshows and open course structure when studying in VLE because they prefer seeing the whole picture of a course.

The Felder-Silverman learning style model (FSLSM) is considered the most appropriate to be used in a computer-based educational system (Carver 1999). Based on this model a corresponding psychometric assessment instrument was created. It was called the Felder-Solomon's Index of Learning Styles (ILS). It is a 44-item questionnaire where learners' personal preferences for each dimension are expressed with values between +11 to -11 per dimension, with steps +/-2. This range comes from the eleven questions that are posed for each dimension. (Gomez 2007; Graf 2007)

3.4. Learning styles in e-learning

Manochehr (2006) has made a study where he compared "the effects on e-learning versus those on traditional instructor-based learning, on student learning, based on students learning styles". The result was that the learning style in traditional learning was irrelevant but in e-learning it was very important. The study showed that learners with an assimilating or converging learning style achieved better learning results in e-learning.

Graf and Kinshuk (2006) studied students' behavior in online courses in 2006. The behavior was studied according to learning style preferences. The FSLSM was also used in this study. The reflective learners spent more time on examples and dealing more intensively with outlines than active learners. Active learners performed better on questions dealing with facts. This is a point that is not supported by the FSLSM. Therefore no significant information can be provided for active and reflective learning styles. The sensing learners visit more often learning material examples and spend more time answering tests and revising them as the intuitive learners. Sequential learners tend to start at the beginning of each chapter where global learners tend to skip learning objects and visit the course overview page more often.

Figure 3.2 is a table about learning styles in learning environment from learner's point of view. At first the learner performs a learning style test and gets an answer which tells what observation channels learners prefers to use in learning and what kind of learner one is. If a learner disagrees with the result s/he can read the test. According to the result the learner can choose the most suitable learning objects and activities from the learning environment. The teacher should provide enough different learning materials in the e-learning environment so that all students are satisfied. The different learning styles should be taken into account also when making exercise works and exams. In an exam there could be for example possibilities to form answers as figures and diagrams.

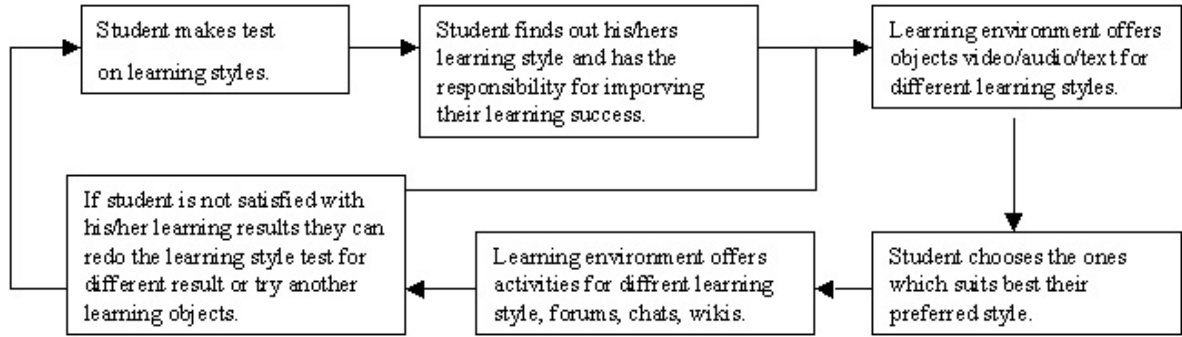


FIGURE 3.2. Learning styles in e-learning environment.

Carmo et al. (2006) studied which type of activities can be used to support different learning styles in learning environment. The Felder-Silverman model was used and the information from students was gathered with the ILS. It was found that visual students had difficulties in processing textual answers. So, the learning environment should propose not only visual activities but also ways for students to create solutions graphically. When other dimensions of learning styles are taken into account the results differ. For example visual/active students gave answers most likely graphically but visual/reflective students in text. This means that the environment should be adaptable including problem solving activities, recorded lectures and discussions. For sequential students the learning environment is easier because information is presented in logical order. The global learners must be taken into account in the environment so that it provides a grand picture or goal of a topic or problem. Sensory learners presented weak abstraction capacity which means that the environment should include a higher diversity of examples and data. The materials presented and used in activities should be a blend of concrete information and abstract concepts.

3.5. Criticism on learning styles

Much study has been addressed to learning styles but still the field over the subject is not clear. Many controversies rise from the fact that there are so many different learning styles. Each style deals with a different aspect on learning but there isn't a style which incorporates all. Coffield et al. (2004) reviews that "the research field of learning styles needs independent, critical, longitudinal and large-scale studies with experimental and control groups to test the claims for pedagogy made by the test developers." (Coffield et al. 2004)

One issue of criticism is that the most popular recommendation is that students' learning styles should be "matched" to their tutor. This "matching hypothesis" means that students' learning style should be similar to the instructional style. (Coffield et al. 2004) Smith, Sekar and Townsend researched this area and found that for each research study

supporting the matching hypothesis there is a study rejecting it (Smith 2002). Another point of criticism is the assessment tools of learning styles. The learning style questionnaires are based on several assumptions, the students are motivated to answer them properly and that the students are aware of their preferred way of learning. Also social and psychological aspects can influence students' answers. (Graf 2007)

The assumption of stability of learning styles is still a controversial issue. Questionnaires themselves raise issues for example that they should fulfill four criteria: construct validity, predictive validity, internal consistency reliability, and test-retest reliability. Construct validity refers to that the instrument measures the theoretical construct that it claims to measure. Predictive validity means that whether the range of behaviour can be seen to have an impact on task performance. The internal consistency reliability means that the homogeneity of the items is intended to measure the same quantity that is the extent to which responses to the items are correlated. The test-retest reliability measures the extent to which an individual achieves the same result when performing the questionnaire twice within a specific period. Coffield's study showed that only three of the 13 learning styles studied came close to these standards. The people who are using these learning questionnaires should be aware of their limitations when interpreting the results. (Goffield et al. 2004)

4. Virtual learning environments (VLE)

4.1. E-learning systems

E-learning systems have several names which basically mean the same: Virtual Learning Environment (VLE), Learning Management System (LMS), Course Management System (CMS), Learning Content Management System (LCMS), Managed Learning Environment (MLE), Learning Support System (LSS) and Learning Platform (LP). In Europe the term VLE is mostly used, but in United States the term CMS is favored over others.

Virtual learning environment (VLE) is computer software that enables the use of multimedia in a simple platform in the net. With the help of VLE the following basic learning tools of online learning can be used: text, still graphics and illustrations, sound and music, video and moving graphics, multimedia. VLEs include users, courses and file management and maintenance. It offers several user levels such as students, teacher and administrator. There are several VLEs offered to customers in the net, some of them are commercial and the others open source. The most used and famous ones are Blackboard, Moodle and WebCT.

According to Manninen (2000, p.30) the differences between learning in a virtual learning environment and in a traditional classroom situation are as follows. In the virtual learning environment the learner's own activity is emphasized and studying takes place at least partly in a simulated situation. Students have an opportunity to directly interact with the learned matter. The learning environment emphasizes problem-centered over subject-centered learning in the planning of teaching. Studying is a comprehensive and lengthy process instead of divided short-term classes. There are different persons, mentors and experts to support the students. Teacher's role changes from information deliverer to organizer and instructing person.

4.2. Adaptivity in virtual learning environment

To create an adaptive learning environment, profound models of students have to be created and actively treated. To improve the environment the information about students' backgrounds and learning preferences should be stored. The simplest way to gather the information is to ask for it directly from students as it was done in this thesis though it is not the most accurate way to get information about cognitive traits, domain competence and

learning style. The more meaningful approach is to track the students' behavior in the virtual learning environment and get the required information there.

Graf (2007) studied how well VLEs can adapt to learning styles and which of the existing non-commercial VLEs are the best to be extended into adaptive VLE. Three minimum criteria were defined concerning the use of VLEs: an active community, a stable development status, and good documentation of the system. An active community means that the VLE is used by many people. It can provide support and have several used systems and activities. To have a stable development status the VLE has to be reliable and not an error-prone product, and executable in an operational environment. Good documentation of the system is very important for installation and customization of the system. The minimum criterion for the didactical objective of the system was that the system's focus has to be on the presentation of content instead of communication functionalities. From the 36 VLEs 9 met these criteria: Atutor, Dokeos, dotLRN, ILIAS, LON-CAPA, Moodle, Open-USS, Sagai and Spaghettilearning. Communication tools, learning objects, management of the user data, usability, adaptation, technical aspects, administration and course management were the issues that were studied in each of the 9 VLEs. The results showed that Moodle can be seen as the best VLE concerning adaptation issues. Extensibility is supported very well and also adaptability and personalization aspects are included in Moodle.

Graf (2007) writes about adaptive virtual learning environments in her Ph.D. thesis. There are several adaptive educational hypermedia systems considering learning styles. CS383 was the first one in 1999 followed by Multimedia Asynchronous Networked Individualized Courseware - MANIC and Intelligent Distributed Environment for Active Learning - IDEAL in 2000 and 2002 respectively. The latest one is Adaptive Hypermedia for All - AHA! in 2005/2006. The majority of the adaptive systems focusing on learning styles are using a collaborative student modeling approach by asking students to answer a questionnaire to detect their learning styles. These questionnaires raise several problems discussed in Chapter 3.5. Graf introduces an automatic approach to detect learning styles in VLE using Felder-Silverman Learning Style Model (FSLSM).

“While collaborative student modeling requires students to explicitly provide some information about their preferences and needs, an automatic student modeling approach is based on the concept of looking at what students are really doing in a course and inferring their preferences and needs from their behavior and actions in the course.” (Graf 2007, pp. 62-63.) When the learning style was found, adaptivity in VLE could be provided. VLE used in Graf's thesis was Moodle. Moodle was enabled to automatically generate and present courses that fit students' learning styles. The layout of the courses changed according to learning style. (Graf 2007)

Figure 4.1 shows the extensions in VLE providing adaptive courses. In Graf's thesis an add-on to Moodle was developed to provide adaptivity. The first extension is the learning style detection tool. The Index of Learning Styles (ILS) questionnaire by Felder and

Soloman was added to the registration form of Moodle. The questionnaire calculated and stored the preferences in student model. The second extension deals with the authoring tool of Moodle and the expert model. Moodle provides different types of learning objects which can be used to create for example exercises or present outlines. The teacher can also add non-adaptive learning material which is not included in the adaptation process. All meta-data given by the teacher is stored in the expert model. The third extension enables the system to automatically provide courses that fit the students' learning style. The fourth step is that individual courses are presented to students via VLE interface. (ibid.)

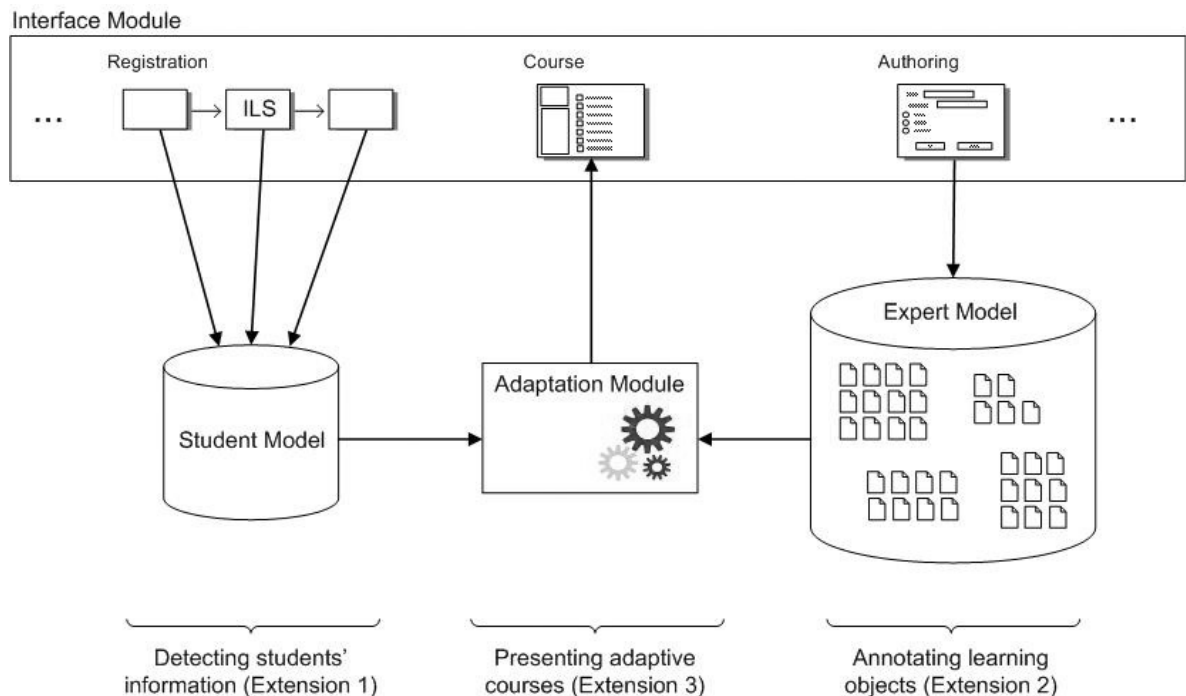


FIGURE 4.1. Extensions on the VLE architecture for providing adaptive courses. (Graf 2007)

In the study where the adaptivity of the VLE course was evaluated students were diverged to three groups, mismatched, standard and matched group. In the mismatched group the students were presented with the course layout that didn't suit to their learning style. In the matched group the layout fitted their learning style and in the standard group the layout was standard. It was found that the students in the mismatched group spent more time in the course and asked for additional learning objects. The matched students spent less time in the course but had on average the same grades as the students in the mismatched and standard groups. (Graf 2007) This shows that by providing students with a tailored web-course according to one's learning style, studying is made easier when student doesn't have to put his energy into finding the wanted learning material but to study it.

Table 4.1 shows which activities and how they should be presented in the VLE according to the FSLSM. Adaptation features can be used to suit the students' preferences in the different learning style dimensions. These activities are taken from Graf's (2007) study. In order to keep the adaptive VLE simple and ask the teachers for as little as possible additional effort only three of the five dimensions of FSLSM were discussed. The visual/verbal dimension was excluded since this dimension asks for different presentation modes (including text, audio and video files) which are time-consuming in their development. (Graf 2007)

TABLE 4.1. Adaptation features and their presentation in an adaptive VLE according to FSLSM (Graf 2007).

Learning style by ILS	Features	Not recommended in VLE
Active	Many exercises Self-assessment tests Outlines once before content objects	Examples
Reflective	Outlines additionally between topics First the learning material in terms of content objects Afterwards examples A conclusion is presented straight after all content objects	Exercises Self-assessment test
Sensing	Many exercises Examples are presented before the abstract learning material Exercises and self-assessment tests only after the learning material	
Intuitive	Self-assessment tests and exercises are recommended to be presented before the learning material. Examples are presented after the abstract content.	Presentation of outlines between topics Examples and exercises
Sequential	Presenting first the learning material, then some examples, and afterwards a self-assessment test and some exercise Outlines are presented only before the content objects	
Global	Providing outlines additionally between the topics, presenting a conclusion straight after the content Providing a high number of examples after the learning material. Examples, exercises, and self-assessment tests in the end	

Active learners like to learn by trying things out and therefore the number of exercises is increased and self-assessment test is presented in the end of each chapter. Because reflective learners like to think things through content objects are presented before

and after examples and tasks. For sensing learners examples and exercises are presented because they like learning data and facts. On the other hand intuitive learners like challenges and therefore self-assessment tests and exercises are recommended to present before the learning material. Since sequential learners prefer to learn in linear steps the learning material is presented first, then some examples, and finally a self-assessment test and some exercises. For global learners who like to get a big picture of the course the outlines should be provided additionally between topics. (ibid.)

4.3. Moodle

Moodle is a free open source virtual learning environment founded and managed by Martin Dougiamas. Moodle acronym means Modular Object-Oriented Dynamic Learning Environment. Moodle includes the following elements:

- Administrative tools
- Student registration and tracking facilities
- Internal mail, discussion and news forums
- Chats with or without moderator
- Basic teaching materials
- Additional resources, including reading material, and links to outside resources in libraries and on the Internet
- Self-assessment quizzes which can be scored automatically
- Formal assessment procedures
- Differential access rights for instructors and students
- Easy authoring tools for creating the necessary documents including the insertion of hyperlinks
- Capable of supporting numerous courses (Moodle.org)

Moodle was created to help educators to have a platform where they could create online courses. Moodle is been developed all the time by several parties who create new qualities and improve existing ones. The first version of Moodle was launched in 2002 and it has developed rapidly over the years. The latest, Version 1.9 was released in March 2008. (Moodle.fi)

4.3.1. Modules and blocks

The Moodle course page consists of three adjacent columns where the outermost columns consist of the blocks and the space between them is the reserved for the course contents. The course section is where the modules are inserted by the teacher. There are several

modules and blocks in Moodle which can be added into course sites. They enable the use of links, course material and are helpful in communication.

Table 4.2 shows some activity modules in Moodle. The assignment module is very often used in RGI-Moodle's courses. The module allows students to submit documents and files into the Moodle and then teacher can grade them. This module is ideal for example for exercise submissions. Forum module gives a platform for the students' and the teachers' discussions. Resource module allows teacher to insert content into the course in the form of labels, files, directories, text and web pages. The Wiki module is very handy in group working. The students can use a Wiki page at the same time and create for example a presentation of learned subjects.

TABLE 4.2. Activity modules in Moodle.

Activity module	Description
Assignment	Allows teacher to grade various types of student submissions.
Chat	Module allows participants to have a real-time synchronous discussion via the web.
Choice	Teacher gives a question and specifies a choice of multiple responses.
Forum	Module provides a permanent space for people to meet and discuss matters both course-related and not. The postings can be viewed in a variety of formats, and can include attachments.
Glossary	Module allows a dictionary or list of definitions to be maintained. It is possible to automatically create links to the entries from throughout the course.
Lesson	Module consists of a number of pages. Each page leads to another page. Students are given content and choices which determine the next page they see.
Questionnaire	Module allows teacher to create surveys.
Quiz	A quiz is an activity that presents students with questions and then processes their responses to give feedback and grades.
Resource	Resources are content: information the teacher wants to bring in the course: label, file, directory or text/webpage.
Wiki	Module enables participants to work together of web pages to add, expand and change the content. Old versions are never deleted and can be restored.

Table 4.3 shows some of the blocks in Moodle. The administration block is shown only to the teachers of the course. It includes tools for editing the course page and also the users of the course. The file manager block is a file archive where students and teachers can

add files. The files can be chosen to be seen only by the user or by the whole course. Everyone can see their own attended courses from the 'my courses' block.

TABLE 4.3. Blocks in Moodle.

Block	The block shows
Activities	Which activities are used in the course.
Administration	Administrative tools for editing the page and users.
Calendar	A mini-calendar which shows event days in different colors.
Course/site description	A HTML block where you can write a description of the course.
File Manager	A folder where students can save their files.
HTML	A HTML block where you can write text in HTML.
Latest news	Latest news updated to courses News forum.
Messages	Messages written through Moodle message system.
My courses	user's courses
Online users	Users who are online in the past 5 minutes.
People	Participants of the course (students and teachers).
Quiz results	Results of a quiz made in a course.
Recent Activity	Recent user activity in the course (forum posts etc.)
Search forums	A search engine for the forums.
Time	A basic round clock.

Surveys can be made by several tools in Moodle. Some of them are designed to create surveys while others are designed for other purposes. In any case they all serve as survey making tools. The tools are: Choice, Quiz, Questionnaire, Survey, Feedback and Form Modules. The Choice module is a tool for making polls. The Survey module contains three ready made surveys about studying, Critical Incident Survey, Constructivist On-line Learning Environment Survey (COLLES) and Attitudes to Thinking and Learning Survey (ATTLS). The Quiz module is a very good tool for making surveys and exams. Pictures and text in HTML can be added to the quiz. The questions added into the quiz can be re-used and used also in other courses. There are the following style choices to make the questions: Multiple Choice, Short Answer, Numerical, True/False, Matching, Embedded Answers, Random Short-Answer Matching, Random, Description, Calculated, and Essay. The Questionnaire module consists of already made questions but they can be deleted or changed and new questions can also be added. The Feedback module is almost the same as the Questionnaire module but teacher can invent the questions by himself. The style choices for the questions are: Check, Dropdown menu, Label, Picture, Radio button, Text area, and Text field. The Form module can also be used to create questionnaires. Header, Text field,

Text area, Radio button, Check box, Dropdown Menu, Document, and Image are the choices of questions that can be used in the Form module. All the answers from every survey making tool can be downloaded as an Excel-table.

4.3.2. Using Moodle for extracurricular activities

Moodle platform is very versatile and can be used also for other purposes besides learning and studying. It has been successfully used for creating communities for different kind of actions. As said, Moodle is suitable for educational purposes (where it was originally planned) but also for information, communication and material delivery purposes. Because of its flexibility Moodle suits different user groups; schools, companies, communities, societies and projects. (Moodle.fi)

Moodle's course sites can be used for example in creating information sites or sites for group working etc. Several groups and communities use Moodle as a platform to deliver information and news. The discussion forums are used to share ideas and opinions.

In RGI one site has been created for a Quality management system inside the institute. Some of Moodle's characteristics, like allowing certain people to see the site and certain people editing it, are in good use in these kinds of sites where the people allowed entering the site has to be limited. Moodle pages for Doctoral thesis and Master of Science project in RGI were built. They are not in use at the moment but could be used actively among the students. The pages could improve the transparency of administrative actions by showing how the theses and projects are carried forward.

In RGI-Moodle all the basic words and concepts that include to Biomedical Engineering (BME) were gathered to the Glossary module. Its full potential hasn't been used yet but in the future it can serve as an important tool for the students. A goal could be set that the students could find large amount of the needed information about the BME field from the Glossary.

4.3.3. Moodle and learning styles

When creating Moodle, online pedagogy and also some learning styles have been thought closely. Especially two distinct learning styles: separate knowing and connected knowing. Connected knowers learn cooperatively and like to build on the ideas of others whereas separate knowers take more critical and argumentative way to learning. In Moodle the learning environment encourages students to be connected knowers. That way a productive environment can be founded to learn in full potential. (Dougiamas 2003)

There are many educational hypermedia systems which include adaptation to learning styles, for example MANIC and IDEAL. However these systems are not very good at supporting teachers and administrators. The virtual learning environments (VLEs) such

as Moodle provide very good administrative support but lack the adaptivity to learning styles. Graf (2007) studied nine different VLEs incorporating adaptivity. She found that the Moodle platform showed the best results concerning adaptivity. (Graf 2007)

There has been research on incorporating learning styles into Moodle. As mentioned in Chapter 4.2 Graf (2007) has studied this field, but it has also been studied by Dureva & Tuparof (2008) from Blagoevgrad South-West University and Bulgarian Academy of Science. They both inserted a module for the studying on learning styles in Moodle. These extension modules are easily implemented into Moodle because it is an open-source VLE which anyone can develop further.

5. Surveys

5.1. Introduction to the surveys

The aim of this thesis is to develop a series of questionnaires to be used in courses. The questionnaires were a part of the teaching development and the teachers can choose the most suitable questionnaires to be used in their courses. Two kinds of surveys were created to be used in courses: a precourse survey in the beginning of a course and a feedback survey at the end of a course. Surveys were also made about the use of the VLE and the students' learning styles. The VLE used in this thesis was Moodle.

The course and Moodle surveys were built with Form which is one of Moodle's tools to create questionnaires. The Form tool was selected because it was the clearest and easiest way to create the surveys. The questions used in the surveys were of choice and multiple choice types. The students had only one chance to answer the survey.

The VLE survey was to gather information about students' attitudes and opinions on Moodle and its use. Thereby the obtained information was used to improve the RGI-Moodle to be more student/study friendly. With the course surveys students' data, expectations and feedback about courses were gathered. A briefing of the surveys was put in the Moodle first page to inform students about the upcoming changes.

5.2. VLE surveys

The survey on Moodle's usability was constructed of two questionnaires. One in the beginning of fall term 2006 and the other in the end of the fall term 2006. The meaning was to find out how students felt Moodle's usability change during the fall term. The surveys were presented in the front page of RGI-Moodle so every student using the VLE could answer the questionnaire. A briefing about the questionnaires was send to several courses in the Moodle and that way students received an email about the existence of the questionnaire.

Pre-survey on VLE

The full survey that was made in the beginning of the fall term can be found from Appendix 1. There were altogether 15 questions about Moodle's usability and students' expectations based on the use of Moodle before.

Questions 1-3 were about students' prior use and experience and expectations on virtual learning environments. Students' use of the virtual environment was asked in Moodle-specific Questions 4-7. These questions were asked to find out students' attitudes and preconceptions about virtual learning environment and especially about Moodle.

Learning styles were asked in Questions 8-9. With the questionnaire students could find out their preferred learning style (visual, auditory, kinesthetic). The next questions were about how one's learning style fits the VLE. With these questions it was found that the general variation between the learning styles among students and how students felt compatibility between their learning style and VLE. Finding out the major preferred learning style the teacher could change his/her teaching to better suit the students' learning.

Question 10 was about where the students use a computer (and in that way also VLE). This was asked to find out if the place was important of how the usability of VLE was experienced. Questions 11-13 were about Moodle's features and activities and their usefulness. Question 14 about using anonym user login was asked to find out if some people would like to comment in conversations as an anonym user. In the end there was an open form for other comments and questions.

Feedback survey on VLE

The survey on Moodle was changed in the second questionnaire and only 9 questions were asked. This was because the desired information was different than in the beginning of the fall term. The questions concentrated more to Moodle's usability issues and its suitability to learning. The questionnaire can be found in Appendix 2.

The first three questions were about VLE's usability during the fall term. It was asked if the course pages were well organized and information was easily found. On the basis on the answers the usability of the VLE course pages can be improved. Question 4 was about needed guidance using VLE. Should there be many students who need guidance, it should be provided. With Question 5 about group working information was gathered if the existing group working methods in the VLE were good enough. Questions 6-8 were to define the usefulness of the features (for example forums, exercises, and quizzes) and therefore their use could be either increased or decreased. Question 9 was the same as in the pre-survey about where the students mostly use computer.

5.3. Course surveys

The surveys about courses were carried out in two parts. First there was a survey before the course had started and then a survey after the course which acts as a feedback questionnaire.

Precourse survey

The pre-survey was made to obtain the basic information about students, their studying habits and expectations about the course. The questionnaire consisted of 16 questions in total where the first six questions considered general information about the students; gender, program and year of study, major and minors. The following ten questions were about the course itself. This survey can be found in Appendix 3.

The questions about learners' readiness for online learning, access and familiarity with the technology and individual learning style are key figures when considering learners' needs on a course. Based on the results of these kinds of questions actions to support students in their learning process can be made. [Online learning; Hughes, J. Supporting the online learner]

The first five questions were about students' general information which was interesting for teacher to know. With the information for example study program the teacher could focus the course's main ideas according to the majority of students. Question 6 was about students' Internet connection at home. This was interesting because there could be some difference between the answers of the students who have an Internet connection (and connection to VLE) at home and of those who have not.

Students' reasons for participating the course was asked in Question 7. With this question the basic motivation for entering the course was found out. Question 8 about prerequisite courses was asked to know if there was any need for rehearsal if the majority of the students hadn't studied them. The next two questions were about students' interest about the subject and their goals and expectations about the course. These aspects showed students' inner motivation towards the course. If there were a major lack of interest, the teacher should pay attention to motivate the students.

Question 11 was about the kind of information students prefer to know before the course starts. Alternatives were lecture and practice schedules, way of performing the course, persons in charge, course materials and other. The next question was if the students would like to know the course arrangements before the course. If the majority of students would prefer having some of the information the teacher should pay attention to that in the next course. Questions 13-15 were about learning style and VLE. In the end there was an open form for other comments and questions.

Feedback survey

The post-survey about the course was to obtain feedback from students. It consisted of 37 questions which were divided into six categories:

1. Learning (12 questions)
2. Course arrangement (4 questions)
3. Lectures (3 questions)
4. Exercises/ Exercise work/ Seminar (9 questions)
5. Evaluation/ feedback (2 questions)
6. Moodle (7 questions)

The questions about Moodle in the part six were concentrated in the use of Moodle in the particular course. The previous survey on Moodle was concentrated in Moodle as a whole, not to certain courses. The questions are found in Appendix 4.

The first 12 questions were about learning. It asked if students felt that they had learned what was meant to learn in the course, if the work load in the course was suitable compared to the credits and if the share of web based learning was suitable. With these questions the teacher can concentrate on developing the course in the way that it serves students better. Students' investment of energy and their attendance in the lectures and exercises was asked. These answers can be compared for example with the learning results. The following issues were asked: which were the reasons hindering students' learning during the course and why they didn't attend classes/exercises. This was asked to see if the reasons were something that the teacher could have an impact on and that in that way improve the course. The question about sufficiency of guidance was made to see if there was a need for more guidance in the course. Two questions about learning styles were also asked. The first was about students' learning style (visual, auditory, kinesthetic) and where a student based his/her answer (the test result from the given learning style survey, intuition about my learning styles or some other test). The second learning style question was about how well one's learning style fitted the course.

Questions 13-16 were about course arrangements. The general grade for the course, the course level of difficulty, the course forming a clear ensemble and the accessibility of the learning materials were asked. These questions were formed to measure the quality of the course. The next three questions were about lectures and their elucidation methods. The questions about exercises covered matters about overlapping between lectures and exercises and the general usefulness of them. In case of dissatisfaction about the previous subjects the teacher or exercise tutor can make changes to the lectures and exercises. Questions 29 and 30 were about course evaluation and the purpose was to see if it was suitable for the course and if the feedback was sufficient. On the basis of the answers the evaluation of the course could be improved. The last seven questions were about the VLE, basically the same questions as in the Moodle survey but they were about using VLE in the course in question.

5.4. Learning style survey

The aim of the learning style survey was to build a questionnaire which acts as a tool for teachers to define students' learning styles. By getting the information about the variety of the students' learning styles, the teacher can develop the course to fit different learning styles. By introducing the questionnaire to the students they get information about learning styles. The students become more aware of their learning style and can develop their own learning. Because the point was not to gather a large range of answers on learning styles but to test the created questionnaire on students, it was carried out only on two courses.

The learning style survey was carried out in spring 2008 on two courses. The first was a Physiology course (LTT-1010) which is an elementary course on Biomedical Engineering. There were students from many different study programs. The course is lectured in Finnish and the survey was made in the same language. The second course was Medical Device Regulations (LTT-1500) which is also lectured in Finnish. In the beginning of the survey there was a short introduction about learning styles and links to the learning styles tests. The survey is in Appendix 5.

The survey gives information about students' interest of learning styles and what learning methods they prefer to support their learning style. One aim of this survey was to study how students with different learning styles perceive existing studying methods. A list of alternative studying/learning methods was introduced to get opinions on which to use in the upcoming courses.

Two tests were introduced to the students. Kolb's learning style test (<http://www.dlc.fi/%7Etenviesti/oppimistyylylit.htm>) and observation channel model test (<http://www.dlc.fi/~tenviesti/miellejarjestelmat.htm>). Both tests are in Finnish. These questionnaires were chosen because they are both easily accessible in the Internet and also because they are in Finnish. The questionnaire was created in Finnish because the majority of the students in the two courses were Finns. It is easier to understand and answer the questions when they are in one's own language.

This survey was built with Quiz module in Moodle. Because this survey was done a year after the first two surveys the RGI Moodle was no longer in use and the survey was carried out in TUT Moodle. The Quiz tool was named as an Exam activity in TUT Moodle.

The Quiz tool is very handy in making questionnaires. The order of the questions can be changed easily and questions once made could be used in multiple surveys/exams. The question types were: calculation, description, essay, compatible answers, fill in tasks, multiple choice, short answer, numeric, randomized compatible short answers and true/false. The ones used in this survey were multiple choice and essay. In multiple choice questions one could choose to have only one answer, the same function as 'Radio buttons' in Questionnaire and Form modules, or multiple answers which is the same function with 'Check boxes'.

6. Survey results

6.1. Results on the VLE surveys

Pre-survey on VLE

There were 14 answers in the pre-survey about the Moodle. Three of the students had used some other VLE than Moodle before, WebCT or A&O. Everyone but one thought that VLEs in general are helpful in learning; one answerer had no image about VLEs. Thirteen of the answerers expected to get the course material by using Moodle, six of them assumed to participate in forum conversations, seven wanted to make contact with the teacher and four with other students. Figure 6.1 shows the results of statements 4-6.

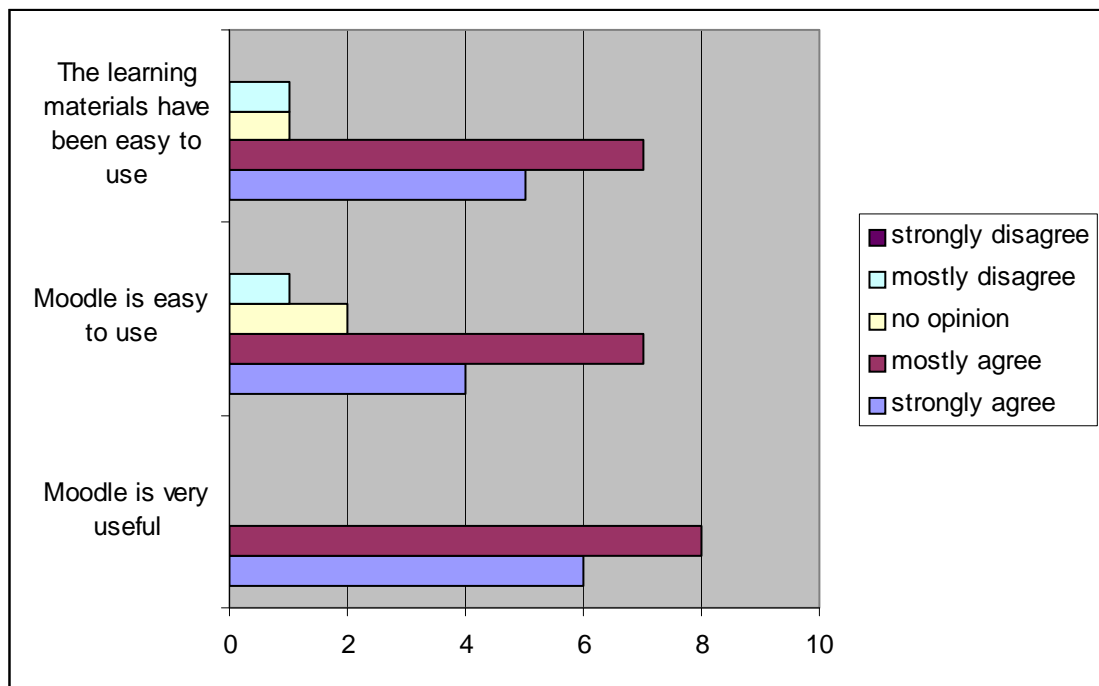


FIGURE 6.1. Results for the statements 4-6.

The activity modules were used by the students as follows:

- Forums: 9 answers
- Exercises: 13 answers

- Calendar: 4 answers
- Quizzes: 10 answers.

In Question 8 the student's best learning style was asked. One learning style test was given as an example to test one's own style. The results are in Figure 6.2.

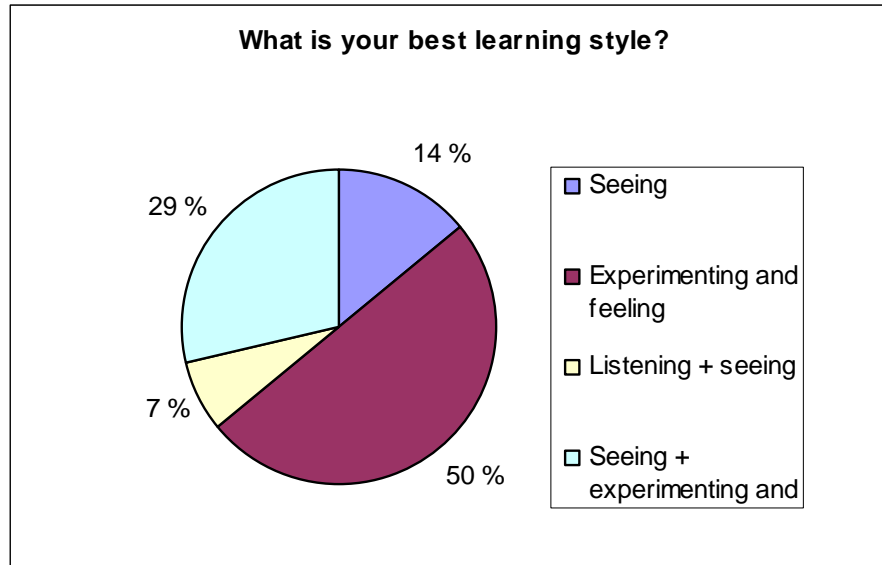


FIGURE 6.2. Answers to the learning style question.

Figure 6.3 shows the results on Question 9, where the opinion on how well one's learning style has fitted into learning in Moodle environment was asked.

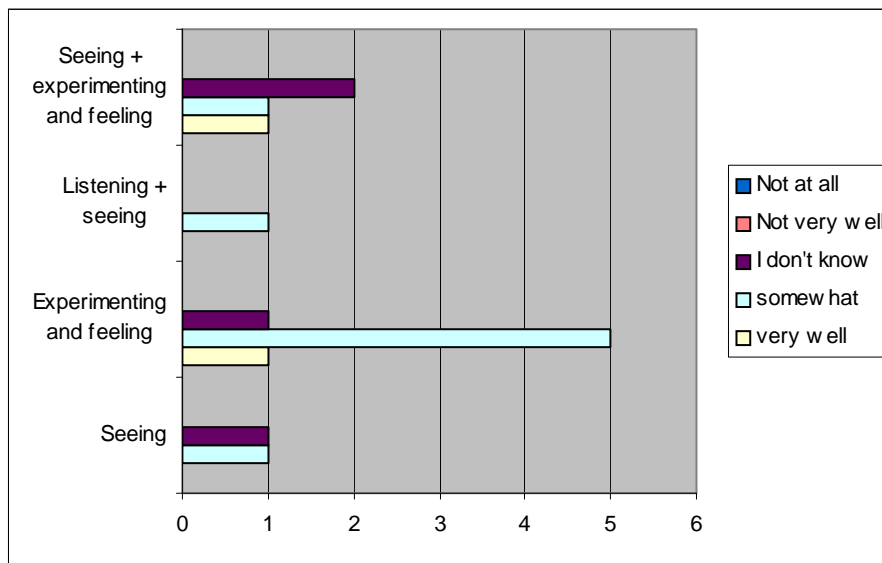


FIGURE 6.3. Answers to the question “How well one's learning style has fit into learning in Moodle environment?”.

Most of the answerers, eleven of them, use Moodle from their home computer, six use it at a school's computer and one from a friend's home computer. The students would like to

add IRC and chat features into Moodle and also some easy way to include pictures and other multimedia into forums. Figure 6.4 shows the results of Questions 12 and 13 where the usefulness of the features/activities was asked. The glossary and the lecture material in general were found useful among others. Other irrelevant features were not mentioned.

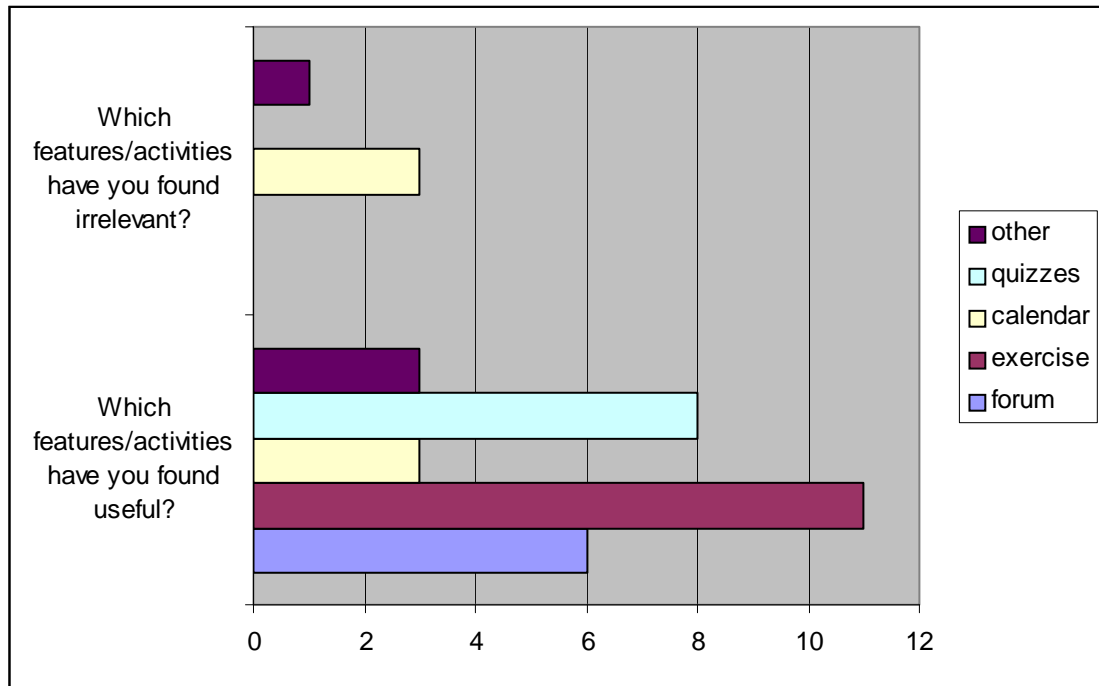


FIGURE 6.4. Answers to the question “Which features have you found irrelevant or useful?”.

In Question 14 about whether the students wanted to use an anonym user identity to ask a “stupid” question was asked. Two of them would have liked to use it, six had no opinion about it and six wouldn’t want to use it. Other comments were: “its working fine” and “it seems to be complex”.

Feedback survey on VLE

Ten answers were received in the feedback survey on the Moodle. Questions 1-5 were about Moodle usability, the results are in Figure 6.5.

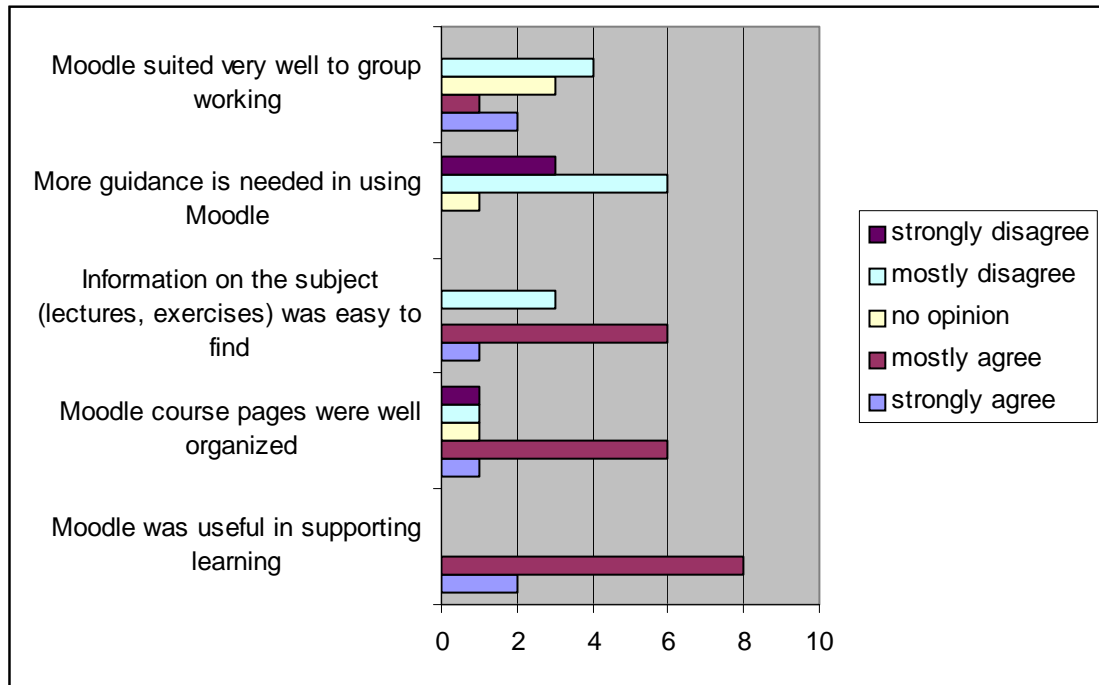


FIGURE 6.5. Answers to the questions about Moodle .

Features that were found useful:

- getting the course material
- forums
- online quizzes
- returning assignments
- calendar and
- news

The features that were found unnecessary were the calendar and the fact that all forum posts are sent as an email to every member of the specific course. The features the students would add to Moodle were:

- More information on overall studies
- Information about timetables
- Information about the course in general
- Course page should be more structured.

Most of the answerers, seven of them, use Moodle from their home computer. Two use it at a school's computer and one from a work computer. Other comments about Moodle were that the Moodle was felt to be a very good online-learning system, the new functions must be known to the teaching staff, if not, they aren't useful, and all the different Moodles of this university should be integrated into only one.

6.2. Results on the course surveys

The course surveys were addressed to the students in three courses. Out of these results, the LTT-1156 Medical Therapy Devices course was taken as an example because it gathered the largest number of answers. The course is a compulsory course for Biomedical engineering.

Precourse survey

In the questionnaire in the beginning of a course, basic information about students was asked. There were 45 answers to this survey in the LTT-1156 course. The questions concerned for example the course arrangements (Figure 6.6).

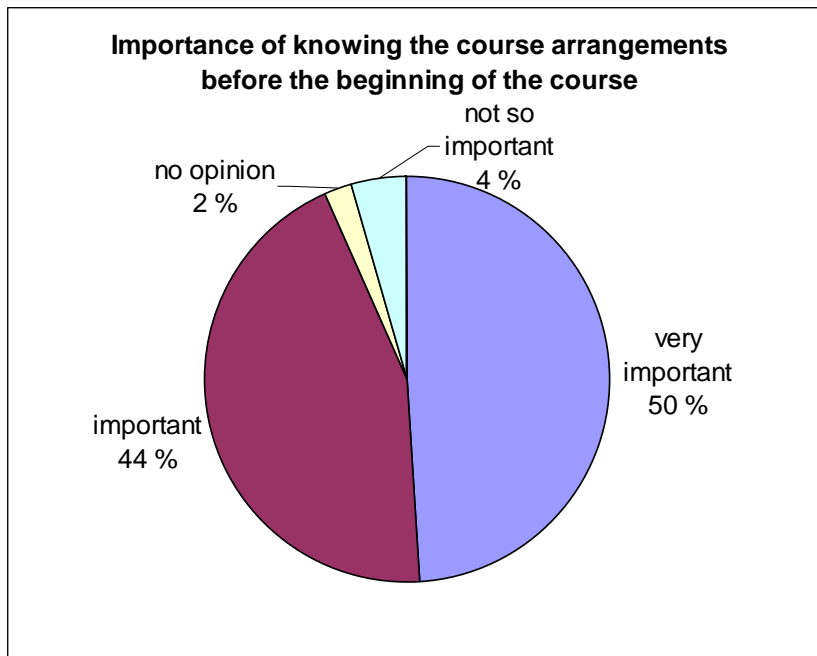


FIGURE 6.6. Answers to the question about the importance of knowing the course arrangements before the course.

Questions about Moodle were also asked, for example, how students would like to use Moodle in the course in question (Figure 6.7).

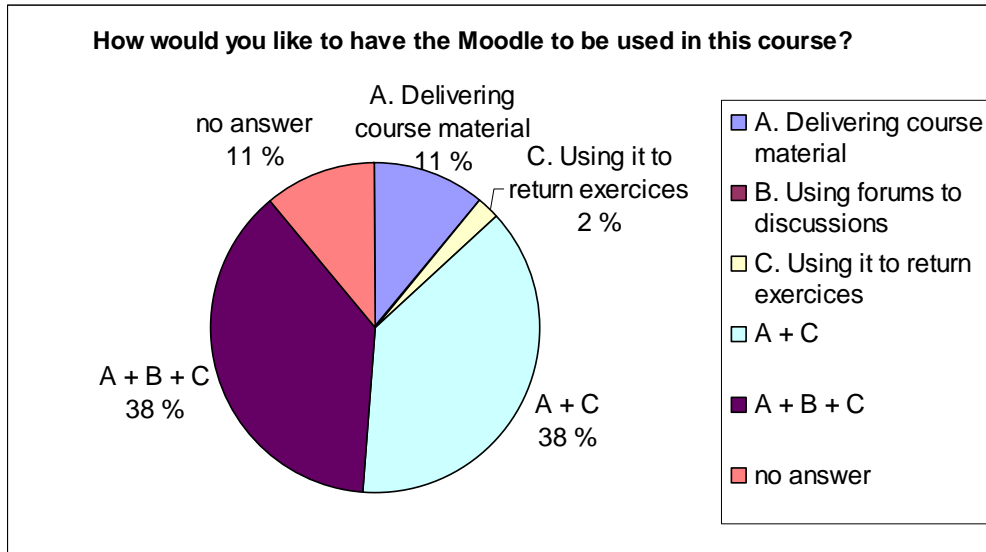


FIGURE 6.7. Answers to the question about how students would like to use Moodle in the course.

Feedback survey

There were in total 29 answers to the feedback questionnaire made at the end of a course.

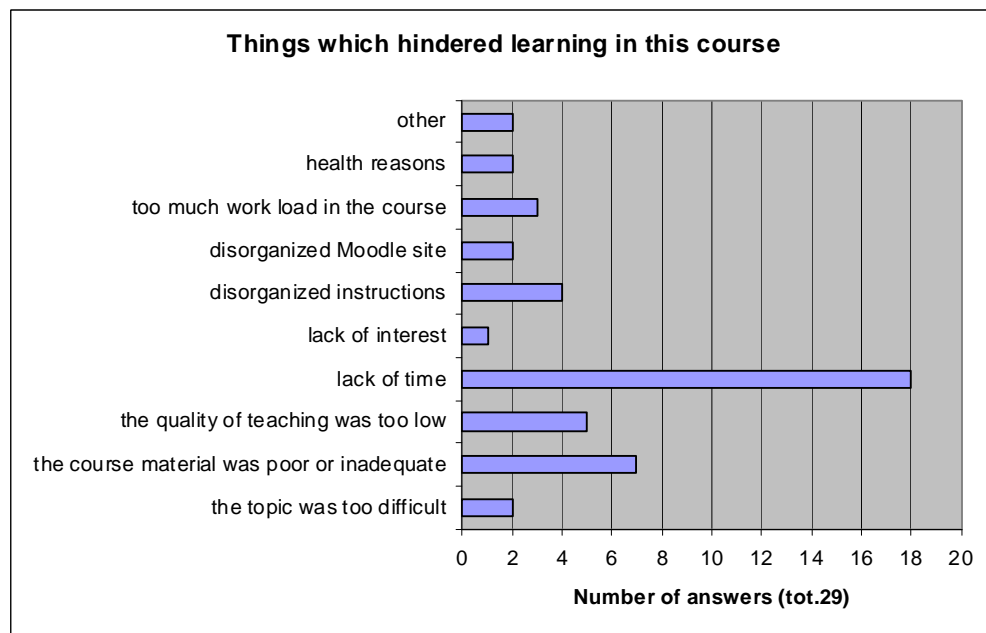


FIGURE 6.8. Answers to the question about things that hindered learning in the course.

The most important results were that the reason that hindered learning in the course and also the reason for not attending the classes or exercises was the lack of time (see Figures 6.8 and 6.9).

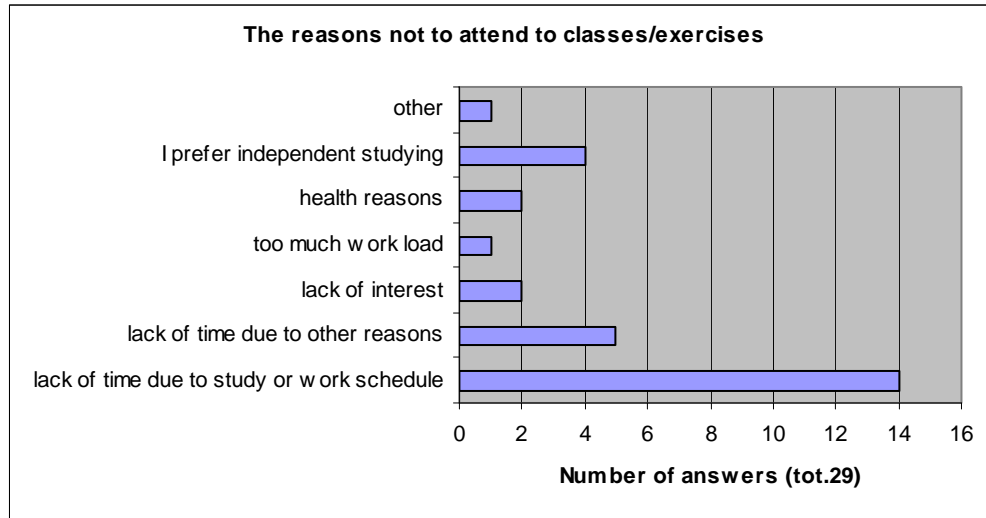


FIGURE 6.9. Answers to the question about reasons not to attend classes/exercises

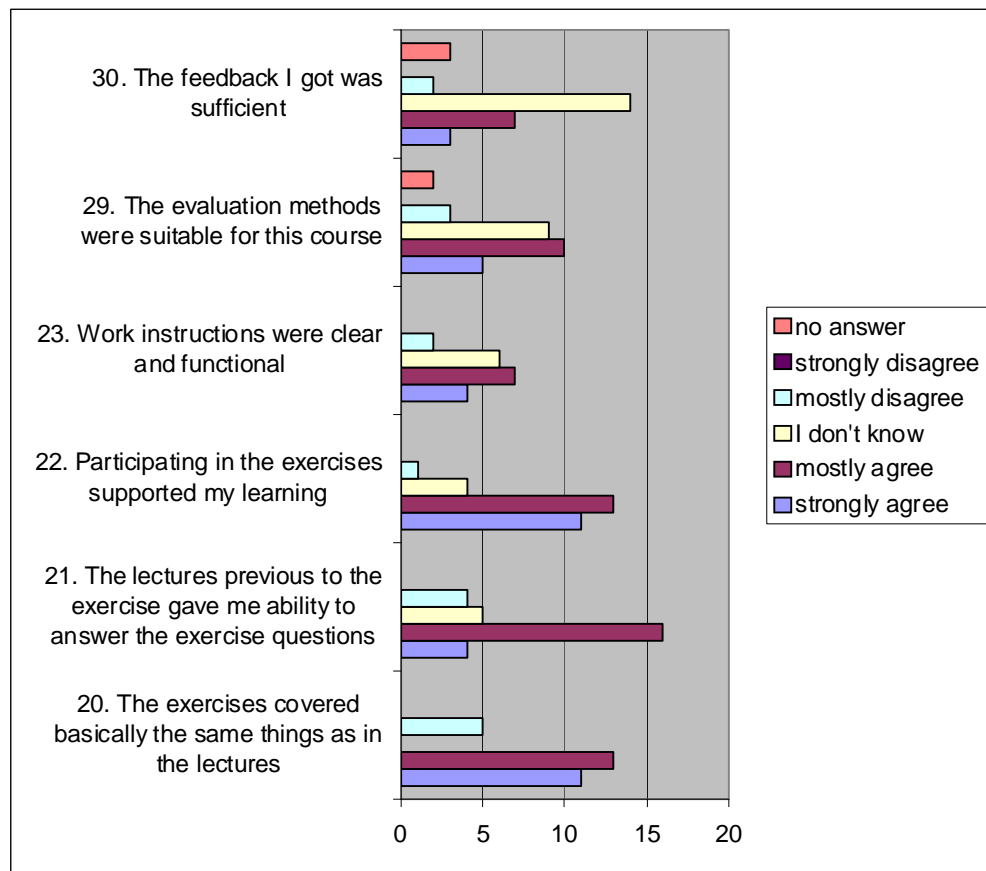


FIGURE 6.10. Answers to Questions 20-23 and 29-30.

In Figure 6.10 there are answers to the questions about the course's exercises and evaluation. The answers about evaluation and feedback were not clear for all because 70%

(12/17) didn't know or did not answer. The rest of the answers mostly declared that evaluation and feedback are sufficient and suitable.

6.3. Results on the learning style survey

The survey was introduced on two courses: for the Physiology course 21 answers were received while the Medical Device Regulations course gathered 11 answers. Because of the small number of answers the results for the two courses were analyzed together.

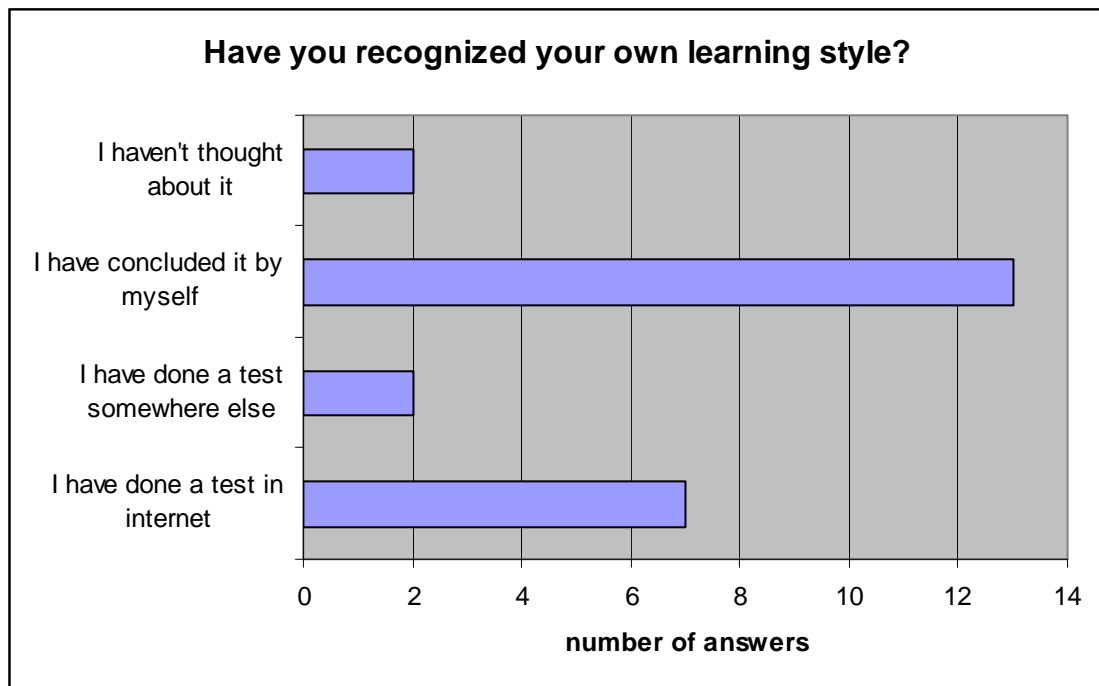


FIGURE 6.11. Answers to the question: "Have you recognized your own learning style?".

In Figures 6.11 – 6.16 are the results of the learning style survey. These results are analyzed in Chapter 7.4. Figure 6.11 shows how the students had recognized their own learning style. It can be seen that most of the students have concluded their learning style by themselves. Figure 6.12 shows the results to the question of students' interest to develop their learning. The answers to the question about teaching's correlation with one's learning style are in figure 6.13. The results from the Kolb's Learning Style Inventory and the VAK learning style test are in Figures 6.14 and 6.15 respectively.

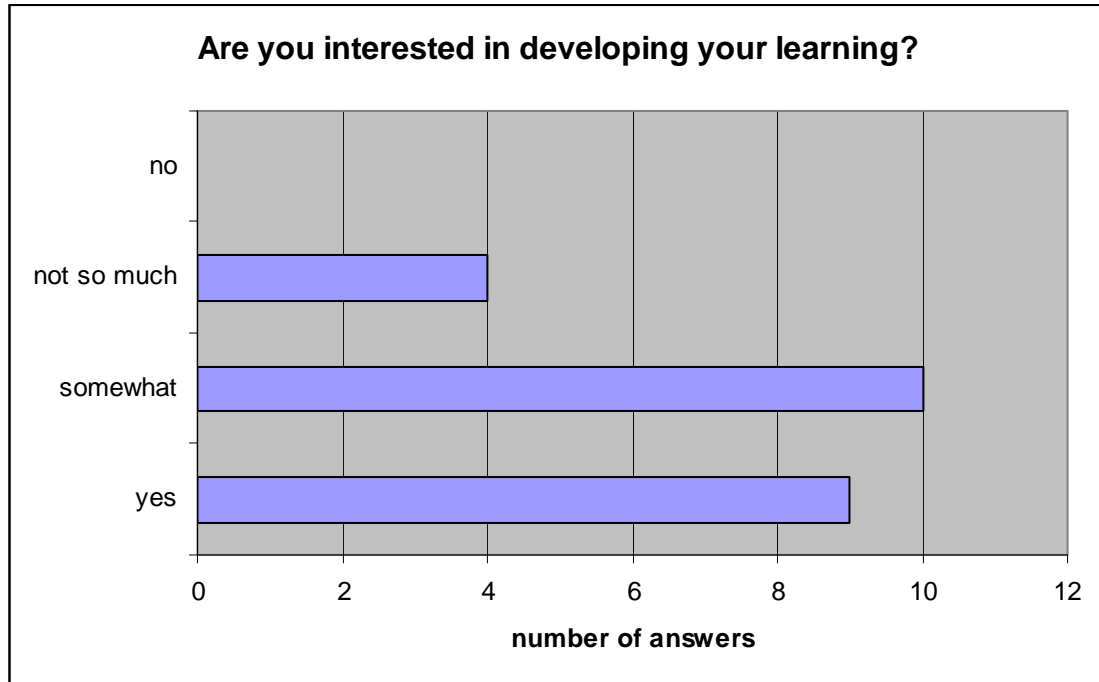


FIGURE 6.12. Answers to the question “Are you interested in developing your learning?”.

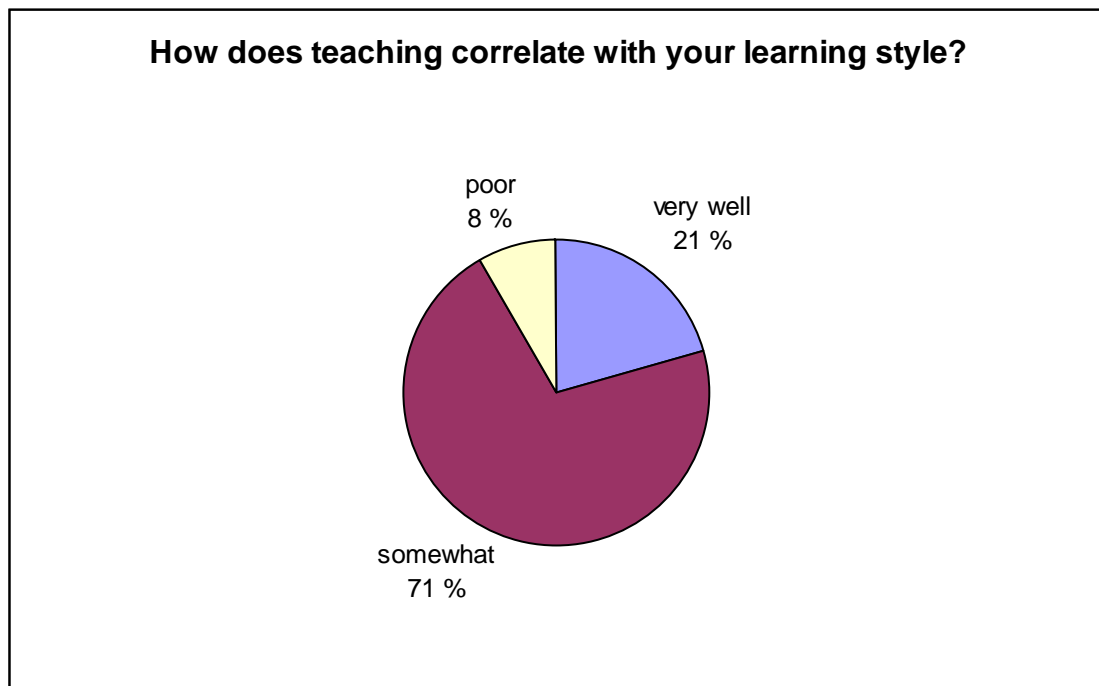


FIGURE 6.13. Answers to the question “How does teaching correlate with your learning style?”.

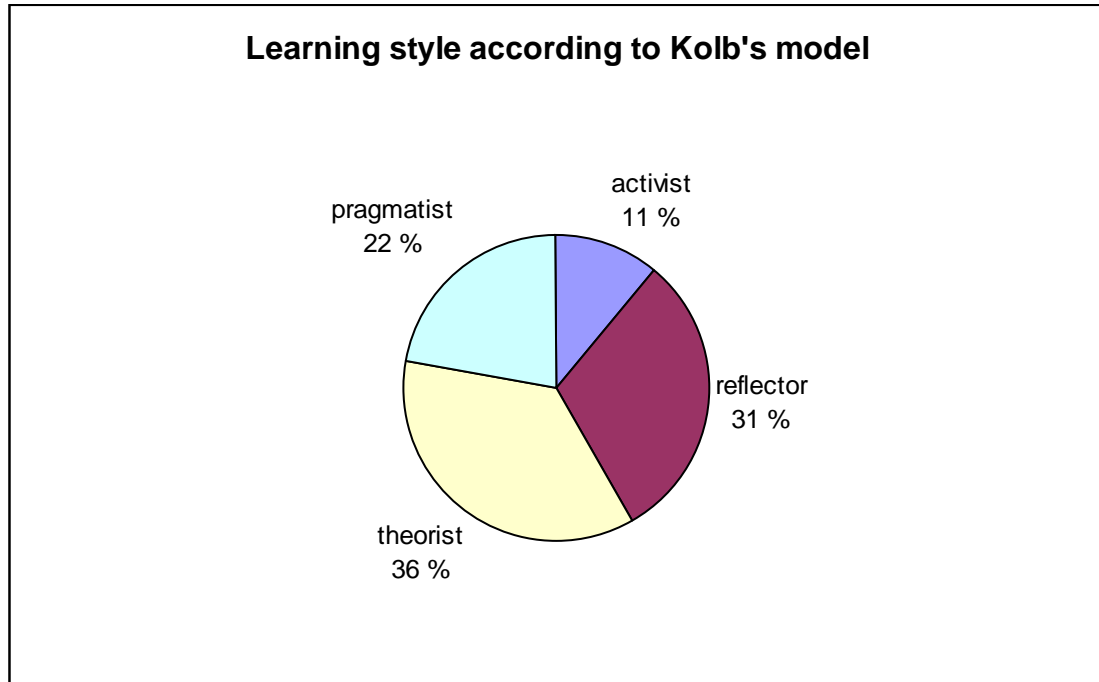


FIGURE 6.14. Answers to the question about learning style with Kolb's model.

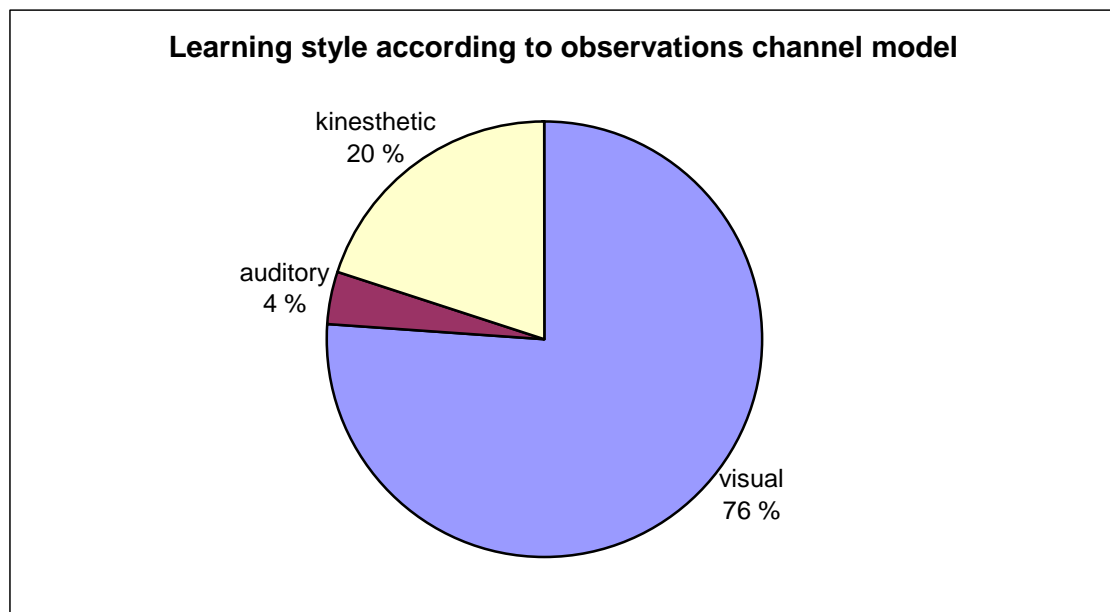


FIGURE 6.15. Answers to the question about learning style with VAK model.

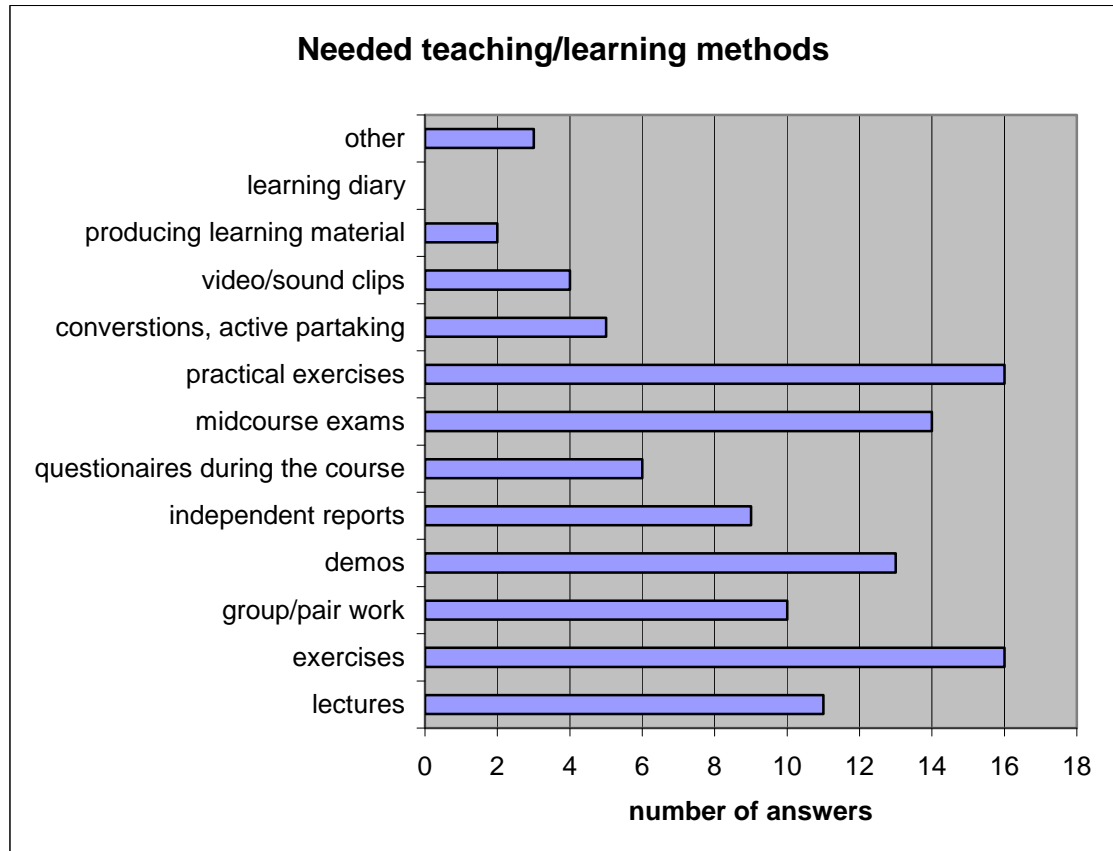


FIGURE 6.16. Answers to the question about needed learning methods.

In Figure 6.16 are the teaching and learning methods which were needed by the students. Practical exercises and exercises in general are the most needed methods. Midcourse exams and demos come right behind them. Lectures, group/pair work and independent reports are answered by many of the students. On the other hand learning diary is not needed by anyone and producing learning material only by two answerers. These are methods that are not used very often. Three of the students offered other methods: using mind maps, problem based learning and getting the learning material always before the course starts.

7. Discussion

7.1. General discussion

The students received the questionnaires with somewhat little interest. Perhaps some extra credits should be given to the answerers or even make the questionnaires compulsory to pass the course to get more answers in the future. The number of the answerers varied between 10 and 45. However, the small number of answers doesn't play an important role in this thesis because the main idea was testing the created questionnaires in a real situation. To motivate the students to give feedback, the benefit from answering should be addressed to them clearly. There are many ways to gather feedback; by Moodle, by Kaiku-system, within an exam, or during lectures.

During the thesis project the use of Moodle in RGI and Tampere University of Technology (TUT) has developed quite many steps further. The RGI-Moodle has changed into TUT-Moodle and that way serves better the students because all the courses are in the same place. However the flexibility to develop and change Moodle has suffered due to the fact that there are only few a people who are allowed to make changes to the virtual learning environment. At TUT the VLE has been used in education now over two years and the use has been changed from experimental to everyday use.

7.2. Surveys

VLE surveys

The idea of the Moodle survey was to compare students' opinions about Moodle before and after the course. Only one student answered both surveys so the results were discussed in general rather than picking answers from certain students. In the pre-survey the students had a very positive image of learning environments and Moodle's usability. Opinions didn't change during the term and in the feedback survey everyone agreed that Moodle was a useful tool and supported learning.

Some students disagreed that the Moodle course pages were well-organized and information about lectures and exercises were easy to find. This was a point which was taken into consideration when making changes to Moodle. It is true that the course pages were quite disorganized because every teacher made different kind of page. To simplify and organize the pages a course layout was created. This layout can be found in Appendix 6.

The course layout was unified so that the same basic things are in the same places in all courses. At the top of the page is clearly the course number and name. Below that the course information and arrangements in general can be found. Used forums and questionnaires are also in the main section at the top of the page. In the center section are also the learning materials, lecture slides and practices et cetera.

Moodle's suitability for group working was both agreed and disagreed. In some courses the teacher had made Moodle pages for groups. Members of the group had teacher's rights in that particular course. It might have been a bit difficult to use the group page and therefore the answer in the survey was disagreeing. Also the lack of that kind of group working facilities could necessitate disagreeing comment. In some courses Wiki component was used as a group working basis.

Although Moodle was felt to be quite complex and layered, the students didn't need guidance in using Moodle. Moodle's structure is said to be layered and there are a lot of different components but when one has used it couple of times it isn't so anymore. Especially among tech students Moodle's complex layout is easily learned. Some students commented on the fact that it would be easier if RGI courses would be in the TUT Moodle than in separate RGI Moodle. In the fall 2007 the courses from RGI Moodle were moved into TUT Moodle to make it clearer for the students. Some of the modules, such as Questionnaire and Form, didn't exist in the TUT Moodle so making questionnaires was limited to the Quiz module.

The Moodle survey could be asked from teachers also. In Appendix 7 there is a preliminary questionnaire to be used as a Moodle survey for teachers. Because teachers are the ones behind the VLE they have several tasks; put up the courses, input learning materials, lead forum discussions and act as a tutor for example. It is up to the teacher as to how functional the course is and that affects the learning results of the learners. Teachers' thoughts about VLE and the use of it in teaching should be studied more. That way the teachers become aware of their importance in the process if using VLE. Developing the use of VLE is a major issue in improving learning results.

Course surveys

The precourse questionnaire can be used to gather information about students' backgrounds. The data can be studied and analyzed in many different ways depending on what information is wanted. For example, students' motives to participate a course can be analyzed by study year. That kind of analysis is illustrated in Figure 7.1. It is not possible to analyze all the data from every course, nor is it necessary. The needed information is easily at hand, for example students' gender or major. It takes some work to analyze the data like in Figure 7.1 and it is done only for some parts.

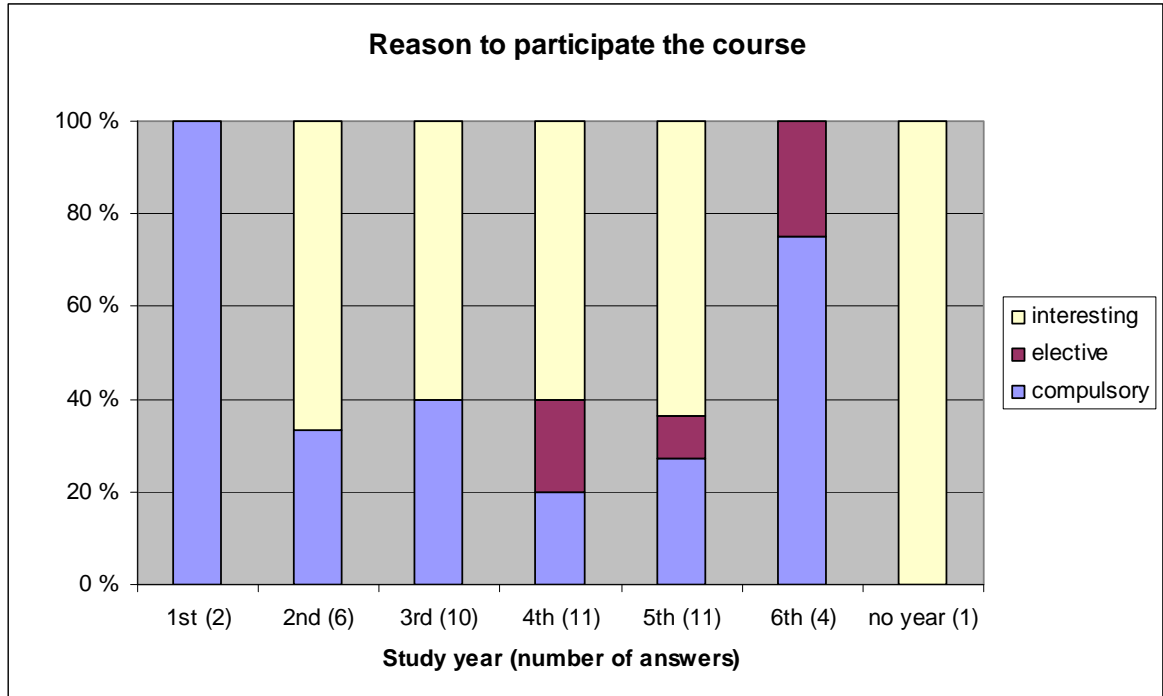


FIGURE 7.1. Table about the motivation to participate the course according to study year.

The background check is handy when information is needed from students' study years and programs of study. The teacher can thereby plan what aspects to emphasize and/or revise. To gather more information with surveys, a/the bonus point system is a good way to inspire students to answer. Because 94% of the students found it important or very important that they got the course arrangements before the course starts, it has to be taken into account to deliver the wanted information beforehand in the course's page in Moodle.

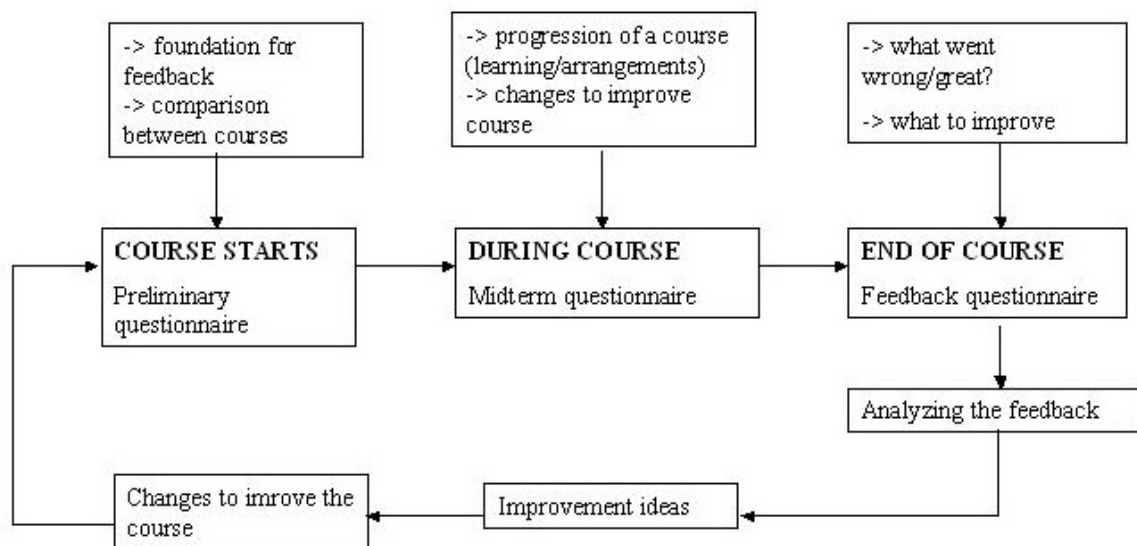


FIGURE 7.2. Course evaluation and feedback system.

The survey in the end of the course is a feedback questionnaire. The feedback questionnaire should be directed at teachers also. In Appendix 7 there is a tentative survey for teachers to be asked in the end of a course. Figure 7.2 presents a system to ‘recycle’ course feedback. This system requires lots of time and effort from teachers.

It takes a lot of work to examine the feedback and present it in a constructed way. There should be an automatic tool from where one could choose the interesting points, for example students’ majors or their attendance in the lectures. It is quite impossible or even necessary for a teacher to do such analysis for every course. The questionnaire can be changed to fit the course/teachers needs by reducing the number of the questions. That way it is easier to find out the wanted information and examine the feedback.

Learning style survey

From Figures 6.11 and 6.12 it can be seen that the students are fairly interested in their own learning and the development of it. From Figure 6.13 it can be seen that 21% of the students answered that the teaching correlates very well their learning style but most of the students (79%) answered that it correlates only somewhat or poorly. This brings up many questions. How teachers utilize the results of this survey? How students’ thoughts about the use of certain learning methods towards their learning style are taken into account? How to improve the courses?

Most of the students answered that their preferred observation channel learning style was visual (see Figure 6.15). From Table 3.1 according to Filppula it can be seen that e-books, lecture notes, videos and tables are helpful in learning for these kinds of students. Most of these mentioned learning methods are widely in use in academic studying. E-books and videos are not yet so common in teaching but should be used more often. The technical capability to use this kind of media is still so new that it hasn’t been used to its full potential so far.

The Kolb’s learning style survey brought more variety to the answers and all four styles were answered as can be seen in Figure 6.14. Theorist was answered 36% and reflector 31%. Because theorists are traditional learners they prefer logical studying and well prepared goals. From Table 3.1 according to Filppula, case studies and questionnaires during the course are ways to enhance the learning on students who prefer this kind of style. Reflectors like organized learning methods and activities which are recommended for them are e-books and forum conversations.

The traditional lectures and practices are not always the best way deliver knowledge to students. Usually it gives a good basis but much more activity is needed both from teacher and student to achieve profound learning. In Figure 6.16 it can be seen that many of the students prefer exercises and practical exercises over the other learning methods. Midcourse exams and demos are also preferred. The fifth best are lectures. This shows that

practical demonstrations are very important to the students. That way they can see or imagine theoretic concepts in real life. Exams during the course are preferred. It is easier to rehearse a smaller amount of information than a larger one at the end of a course.

7.3. Improvement proposals

When planning a course to a virtual learning environment (VLE) attention should be paid to several aspects. The planning process starts with brainwork, what skills and information is there to be learned. Next step is to think what kind of learning materials are provided so that different kinds of learners are taken into account. It is also important to think how the learning materials are organized in the course website. The previous two aspects are included in adaptive VLE. The VLE requires an add-on to perform the adaptivity. It is possible to arrange learning objects according to different learning styles to some amount but it takes a lot of time and energy.

To notice different kinds of learners in the virtual learning environment course, sufficient different learning methods should be provided. Choices should be given on how to pass the course; exam, presentation, group work for example. Clear instructions, information about course arrangements early enough, text material, links to other resources and forum conversations are also important in general.

The Kaiku is a course feedback system used in TTY. It gives the teachers a way to gather feedback about the courses. It is possible to create one's own multiple choice and open questions to the question form. The purpose of the Kaiku system is to evaluate the quality of teaching from the viewpoint of how well the courses are succeeded. The teachers develop the courses on the grounds of the questionnaire results.

7.3.1. Questionnaires to courses

It is important to use questionnaires in gathering information about students (general info, studying habits, learning styles etc.) to be able to develop VLE courses in more student-friendly way and that way improve their learning. The teachers can choose which of the questionnaires they want to use in their courses. In this thesis a wide variety of questions was developed and addressed to the students. It was found that some questions were more irrelevant than others. In the following sub-sections the most relevant ones are picked up.

Figure 7.3 shows the variety of questionnaires there are to be included in a course. Firstly there is a pre-questionnaire in the beginning of the course, which should include questions about participating students: study year, study program, major, attended prerequisite courses, learning style and what activities in VLE s/he will use. Basing on this information about students' background teacher modifies the existing course to suite the students' needs in question. For example if a majority of the students hasn't attended the

prerequisite courses, a revision of those subjects are in order. Some of the basic student information can be found from the Personified Student Portal (Personoitu Opiskelija Portaali - POP) and therefore the same questions can be omitted from the questionnaires when the required information is found otherwise.

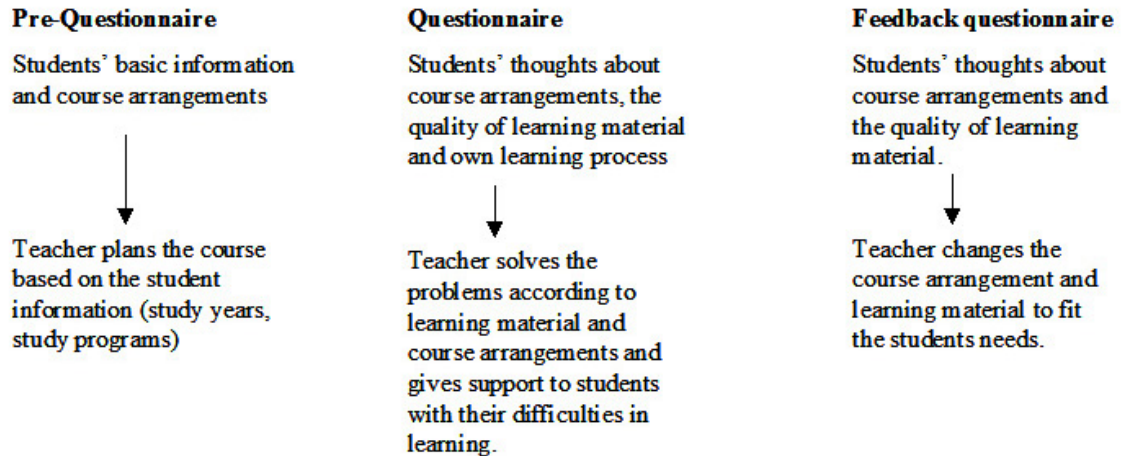


FIGURE 7.3. Questionnaires throughout a course.

As Graf pointed out the best learning style model for computer based educational systems is the Felder-Silverman learning style model (FSLSM). It describes the learning style on a more detailed level than the other models. Based on the FSLMS a questionnaire was developed by Felder and Solomon, Index of Learning Style (ILS). This questionnaire's website can be found at: <http://www.engr.ncsu.edu/learningstyles/ilsweb.html>. It is also interesting to ask on which grounds the student's answer about learning style is based on. Is it based on the test result from ILS, intuition or some other test? The ILS questionnaire results give the student ways to improve their learning.

Second questionnaire is to be made during the course. The purpose is to gather information on the students' thoughts about course arrangements and learning material. If there are lacks in the learning material or problems in course arrangements the teacher should solve them. Students' thoughts about their learning process should also be questioned. If they are unsure about their learning style or have problems with studying habits the teacher should help them as much as s/he can.

A feedback questionnaire is addressed at the end of a course. Students' thoughts about the course's work amount and what hindered their learning should be asked. It is also important to know if the amount of guidance has been suitable. In the feedback questionnaire the course's suitability to one's learning style should be asked to get a picture on how adaptive the course is according to learning styles. There should be questions about the course's level of difficulty, elucidation methods during the course and if the learning materials were clear and easy to hand. Another point is to be focused on exercises,

especially their overlapping with lectures, their quality and if the lectures had given ability to perform the exercises properly. Students' opinions about the evaluation methods in the course are important to know. The sufficiency of feedback is also a subject of interest. One of the most important parts is to ask questions about course site in VLE, its clearness and functionality. Questions about which learning objects students used and which activities they found relevant/irrelevant.

7.3.2. Students' awareness on learning styles

It is important to focus on students' awareness of learning styles. Everyone should be encouraged to take the Felder's learning style test (ILS) and see the results. From the test's website students can find helpful tips and suitable learning objects for their learning according to their learning styles. Because there are many different learning style questionnaires and learning styles available one should not focus on just one style but incorporate different methods for own use. The learning style changing between courses and over time is a point that should be told to the students.

The relevancy of using the questionnaires as the only tool for gathering feedback and information can be called to question. The questionnaires are very useful when questioning fairly stable issues such as background information. They are also a good way to get feedback. By using just a questionnaire to find out students' learning styles is not the best way. The questionnaires raise several problems as has been discussed in Chapter 3.5, for example students' motivation and capability to fill out the questionnaires. The reliability of the questionnaires themselves is to be questioned. By developing an extension to a VLE that would automatically detect students' learning styles is the solution. There would be no need to talk about specific learning styles anymore but different learning preferences that differ from one to another.

For the students a more direct way to have an influence on the course than the questionnaires is to use the discussion forum or the direct feedback to the teacher. However they are used very little maybe because the learning environment is still quite a new tool in learning or because there is no greater need for giving quick feedback. Giving the feedback only at the end of course can be frustrating to the students because their answers have an effect only to next time the course is carried out. Therefore it is important to gather feedback also in the middle of the course. The students are more eager to answer the questionnaires if they benefit from it during the course.

7.3.3. Future work

Most of the learners are interested in their learning style but do they really know it? Is the preferred learning style really the best way to learn? Everyone should at least take the

learning style tests and see the results. Adaptive learning environments are being developed and their usefulness in incorporating learning styles is interesting.

To improve the quality of online courses, teachers should take an active role in it. To find out teachers' state of behavior in VLE, a questionnaire for teachers should be done. In Appendix 7 there is a questionnaire that can be used as a basis to the final questionnaire. There should be questions about how much teachers know about VLE, the use of it and how much they have used it in the past and use it at the moment. How much they know about taking learning styles into account. Tutorials should be made for teachers on how to effectively use the VLE and especially how to take learning styles into account.

Because people learn differently, the idea is to offer different forms of learning. Limitations in virtual environment occur. For example, for kinesthetic learners there are no chances of doing things concretely. However online learning is not limited only to the computer and students don't need to sit next to a computer all the time. Text can be printed out and in the future learning materials can be uploaded to portable devices and accessed anywhere. Although the use of the Moodle platform is now limited, it doesn't mean it cannot be used effectively and flexibly to meet different learners needs. Because the environment is very flexible and teachers can upload so many different activities, every learning style can be taken into account but not if teachers are unaware of what they are doing.

Moodle can be developed further to be more adaptive to learning styles. Graf (2007) and Dureva & Tuparof (2008) have studied Moodle's capability to incorporate learning styles. It is possible to include add-ons to Moodle. With these add-ons or extensions students' learning styles can be defined automatically and taken into account by offering tailored courses in VLE. Moodle's adaptability is not a problem in developing it to better incorporate learning styles. As Graf (2007) showed in her study Moodle was the most adaptive from nine different VLEs. The following extensions are to be included to the VLE so it can be adaptable to different learning styles:

- Students' information detection module
- Expert module
- Adaptation module

The first module gathers information from the questionnaires that are addressed to students, background information and learning styles for example. The teacher adds several learning objects that support all the learning styles to the expert module. The adaptation module combines the information from the two previous modules and creates a course layout that serves best the student's learning style in question. The first module should be developed so that it could detect student's learning style automatically and not from any specific learning style questionnaire. The module should track the student's behavior in the VLE and find out for example which learning objects and how often he uses. That way the student's learning preference is found and a specified course layout can be addressed to the student.

8. Conclusion

[1] The objective of this thesis was to make a review on learning styles in Virtual Learning Environments. The following conclusions were made. VLE has to be clear and functional to obtain good learning results. If there are multiple courses in VLE their appearance should be unified in purpose to get simple and easy access to course information and learning materials. The VLE can be used in many more ways than just learning. They can serve as storage for different kinds of information or for example be university department personnel's place to collect ideas and information.

[2] The VLEs are successful in e-learning but take learning styles poorly into consideration. To make the VLE adaptive for different learning styles, learners' behavior in learning environments has to be studied. The challenge is to get enough information to process. With the obtained data, student models can be created and thereby find the students' learning preferences. By including multiple learning objects that serve all kinds of learning styles the VLE can be developed to be adaptive for learners' needs.

[3] It is important to focus on students' awareness of learning styles. Everyone should be encouraged to take the Felder's learning style test (ILS) and see the results. From the test's website students can find helpful tips and suitable learning objects for their learning according to their learning styles. Because there are many different learning style questionnaires and learning styles available one should not focus on just one style but incorporate different methods for own use. The learning style changing between courses and over time is a point that should be told to the students.

[4] The planning of web-based teaching with respect to learning styles is complicated because every learner's individual needs can not be taken into consideration. The planning has to be done in a way that different styles are offered different learning methods. For example for diverged learning style e-books and forums are recommended. The idea is to offer so many different learning objects (text, graphics, videos et cetera) and ways to complete a course (for example group work, exam or literal review) that the learning styles are taken into account.

[5] Questionnaires in the beginning and at the end of a course can be delivered to the students to find out their background information and get feedback. The feedback is important when redesigning a course. Feedback is also important to ask during a course to find out the defects in it. The students might answer more eagerly to the feedback questionnaire when it is during a course because that way they can get the benefit out of it.

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APPENDIX 1: Pre-survey of VLE

1. Have you used some other learning environments (e.g. WebCT, etc.) than Moodle before?
 - a) Yes (specify which ones)
 - b) No

2. What kind of image do you have about learning environments?
 - a) they are helpful in learning
 - b) they are not helpful in learning
 - c) I have no image about learning environments
 - d) other (specify)

3. What expectations do you have about using Moodle?
 - a) to get the course material
 - b) to participate in forum conversations
 - c) make contact with teacher
 - d) make contact with other students
 - e) other (specify)

4. Moodle is very useful.
 - a) strongly agree
 - b) mostly agree
 - c) no opinion
 - d) mostly disagree
 - e) strongly disagree

5. Moodle is easy to use.
 - a) strongly agree – e) strongly disagree

6. The learning materials have been easy to use.
 - a) strongly agree – e) strongly disagree

7. What different activities have you used?
 - a) forums
 - b) exercises
 - c) calendar
 - d) quizzes
 - e) other (specify)

8. What is your best learning style?

Test yourself with the following test:
http://www.metamath.com/multiple/multiple_choice_questions.html

 - a) Learning by listening (Auditory)
 - b) Learning by seeing (Visual)
 - c) Learning by experimenting and feeling (Kinesthetic)

9. How well has your learning style fit into learning in Moodle in past courses?
 - a) Very well
 - b) Somewhat

- c) I don't know
- d) Not very well
- e) Not at all

10. Where do you use Moodle the most?

- a) at school's computer
- b) at home computer
- c) at friend's home computer
- d) at some other public computer
- e) other (specify)

11. What extra features would you like to have added to Moodle?

- a) open field

12. Which features/activities have you found useful (why)?

- a) forums
- b) exercises
- c) calendar
- d) quizzes
- e) other (specify)

13. Which features/activities have you found irrelevant (why)?

- a) forums
- b) exercises
- c) calendar
- d) quizzes
- e) other (specify)

14. Would you like to use Anonym user (e.g. Teemu Teekkari) to login into Moodle to ask "stupid questions"?

- a) yes
- b) no opinion
- c) no

15. Other comments about Moodle

- open field

APPENDIX 2: Feedback survey of VLE

1. I felt Moodle was very useful in supporting learning.
 - a) strongly agree
 - b) mostly agree
 - c) no opinion
 - d) mostly disagree
 - e) strongly disagree
2. I felt Moodle course pages were well-organized.
 - a) strongly agree – e) strongly disagree
3. I found enough/easily information of the subject (lectures, exercises) that I was looking for.
 - a) strongly agree – e) strongly disagree
4. I would have needed more guidance in using Moodle.
 - a) strongly agree – e) strongly disagree
5. Moodle suited very well group working.
 - a) strongly agree – e) strongly disagree
6. Which features did you find the most useful/important?
7. Which features did you find unnecessary?
8. What extra features would you add to Moodle?
9. Where do you use Moodle the most?
 - a) at school's computer
 - b) at work computer
 - c) at home computer
 - d) at friend's home computer
 - e) at some other public computer
 - f) other (specify)

APPENDIX 3: Pre-course survey

General questions

1. Gender
 - a) Male
 - b) Female

2. What is your program of study?
 - a) Architecture
 - b) Automation Engineering
 - c) Biotechnology
 - d) Civil Engineering
 - e) Communications and Electronics
 - f) Electrical Engineering
 - g) Environmental and Energy Technology
 - h) Industrial Engineering and Management
 - i) Information and Knowledge Management
 - j) Information Technology
 - k) Materials Engineering
 - l) Mechanical Engineering
 - m) Science and Engineering
 - n) Fibre, Textile and Clothing Science

3. What is your year?
 - a) 1st – g) nth

4. What is your major?
 - a) Biomedical engineering
 - b) Electronics
 - c) Signal processing
 - d) Software systems
 - e) Biomaterials
 - f) Other (specify)
 - g) Not chosen yet

5. Which are your minors?
 - a) Digital and computer systems
 - b) Signal processing
 - c) Software systems
 - d) Electronics
 - e) Biomedical engineering
 - f) Biomaterials
 - g) Measurement and information technology
 - h) Physics
 - i) Power engineering
 - j) Automation and control
 - k) Power electronics
 - l) Communication engineering

- m) Other (specify)
- n) Not chosen yet

6. Do you have computer with internet connection at home?

Questions about the course

7. I'm participating to this course because it is:

- c) compulsory
- d) elective
- e) interesting
- f) recommended by a friend
- g) easy credit units
- h) other (specify)

8. Have you studied prerequisite courses demanded?

– List of the courses –

- i) Yes (all of them)
- j) Yes (some of them)
- k) No
- l) There are no prerequisite courses

9. How much does this subject interest you?

- a) Very much
- b) Somewhat
- c) Neutral
- d) Not very much
- e) Not at all

10. What goals and expectations do you have for this course?

- a) to pass the course and get the credit units.
- b) to understand the basic concepts of the course.
- c) to learn profound things about the subject.
- d) to be able to apply learned things into practice.
- e) other (specify)

11. What information would you like to know about course arrangements before the course?

- a) lecture and practice schedules.
- b) way of performing the course.
- c) persons in charge.
- d) course materials.
- e) other (specify)

12. How important it is to you to know the course arrangements well before the beginning of the course?

- a) very important
- b) important
- c) no opinion
- d) not so important
- e) not important

13. What is your best learning style?
Test yourself with the following test:
http://www.metamath.com/multiple/multiple_choice_questions.html
- d) Learning by listening (Auditory)
 - e) Learning by seeing (Visual)
 - f) Learning by experimenting and feeling (Kinesthetic)
14. Have you used Moodle learning environment before?
- a) Yes
 - b) No (skip the last question)
15. How would you like to have the Moodle to be used in this course?
- a) delivering the course material
 - b) using forums to discussions
 - c) using it to return exercises
 - d) other (specify)

Open form (comments)

APPENDIX 4: Feedback survey

Learning

1. I learned what it was meant to in this course.
 - a) strongly agree
 - b) mostly agree
 - c) I don't know
 - d) mostly disagree
 - e) strongly disagree

2. The work amount of the course compared to the credits was...
 - a) Too high.
 - b) Suitable.
 - c) Too low.

3. I invested energy in learning...
 - a) Very much
 - b) Normal
 - c) Not much

4. My attendance to the lectures.
 - a) 0-30%
 - b) 30-60%
 - c) 60-100%

5. My attendance to the exercises.
 - a) 0-30%
 - b) 30-60%
 - c) 60-100%

6. The share of web-based learning in this course was...
 - a) Too high
 - b) Suitable
 - c) Too little

7. What hindered your learning the most in the course?
 - a) the topic was too difficult
 - b) the course material was poor or inadequate
 - c) the quality of teaching was too low
 - d) lack of time
 - e) lack of interest
 - f) disorganized instructions
 - g) disorganized Moodle site
 - h) too much work load in the course
 - i) health reasons
 - j) other (specify)

8. If you didn't attend to the classes/ exercises, why?

- a) lack of time due to study or work schedule
- b) lack of time due to other reasons
- c) lack of interest
- d) too much work load
- e) health reasons
- f) I prefer independent studying
- g) other (specify)

9. I got enough guidance from the course personnel (a-e)

10. Which things remained unclear?

- a) open field

11. Choose from the following which are the best learning styles for you?

Test yourself: http://www.metamath.com/multiple/multiple_choice_questions.html

My answer is based on

- the test result from the above internet site
- intuition about my learning styles
- some other test

- a) Learning by listening (Auditive)
- b) Learning by seeing (Visual)
- c) Learning by experimenting and feeling (Kinesthetic)

12. How did your learning style fit into learning in this course?

- a) Very well
- b) Somewhat
- c) I don't know
- d) Not very well
- e) Not at all

Course arrangements

13. General grade for the course. 1-5

14. The course formed a clear ensemble. (a-e)

15. How would you evaluate courses level of difficulty?

- a) easy
- b) medium
- c) hard

16. Did you get the learning material (handouts, books, articles) without problems/on time?

- a) yes
- b) no (where were the problems?)

Lectures

17. General grade for teaching. 1-5

18. Which of the elucidation methods (powerpoint slides, transparencies, etc.) were good and helpful in learning?
a) Open field
19. What other elucidation methods would you have needed or changed?
a) Open field

Exercises/ Exercise work/ Seminar

20. The exercises covered basically the same things as in the lectures. (a-e)
21. The lectures previous to the exercise gave me ability to answer the exercise questions. (a-e)
22. Participating in the exercises supported my learning. (a-e)

If there was an exercise work in this course, please answer the following three questions:

23. Work instructions were clear and functional. (a-e)
24. The exercise work was very well suited to this course. (a-e)
25. The exercise work was useful and I learned a lot. (a-e)

If there was a seminar in this course, please answer the following question:

26. The seminar was useful and I learned a lot. (a-e)
27. What was good about the exercises/ exercise work/ seminar?
a) Open field
28. What went wrong in the exercises/ exercise work/ seminar?
a) Open field

Evaluation/feedback

29. The evaluation methods were suitable for this course. (a-e)
30. Was the feedback you got sufficient?
a) Yes
b) Somewhat
c) No

Moodle

31. Which activities did you use in this course?
a) forums
b) assignment
c) calendar
d) quizzes

- e) chat
- f) other (specify)

32. Which activities did you find useful?

33. Which activities did you find irrelevant?

34. Did you find all the information what you wanted from the courses Moodle site?

- a) Yes
- b) No (what things you didn't find?)

35. Was the course's Moodle site clear and functional?

- a) Yes
- b) No (where were the problems?)

36. Other comments about Moodle.

- a) Open form

37. Was this questionnaire clear and easy to fill?

- a) Yes
- b) no

APPENDIX 5: Learning style survey

Oletko tiedostanut oman tyylisi oppia? Miten?

- tehnyt testin internetissä
- tehnyt testin jotenkin muuten
- itse päätellyt asian
- en ole tietoisesti ajatellut asiaa

Oletko kiinnostunut oman oppimisesi kehittämisestä?

- kyllä
- jonkin verran
- en erityisemmin
- en

Mikä on oppimistyylisi Kolbin mallin mukaan?

- Osallistuja
- Tarkkailija
- Päätelijä
- Toteuttaja

Mikä on oppimistyylisi miellejärjestelmämallin mukaan?

- näköaisti
- kuuloaisti
- tuntoaisti

Miten yleisesti miellät opetuksen tukevan oppimistyyliäsi TTY:llä/RGI:llä?

- hyvin
- kohtalaisesti
- huonosti

Millaisia opetus-/oppimismenetelmiä kaipaisit tukemaan omaa oppimistyyliäsi (millä tahansa TTY:n kurssilla)?

- luennot
- harjoitukset
- ryhmätyöskentely
- parityöskentely
- demot
- itsenäiset raportit
- kyselyt kurssin kuluessa
- välitentit
- käytännön harjoitukset
- video/ääni leikkeet/ohjeet
- keskustelut, aktiivinen osallistuminen
- oppimateriaalin tuottaminen
- oppimispäiväkirja
- [oma menetelmä]

APPENDIX 6: Course layout

KURSSIPOHJA
 RG:edu » KURSSIPOHJA

You are logged in as Essi Kanninen (Logout) [Turn editing on](#)

My courses

Activities

- Assignments
- Books
- Forms
- Forums
- Quizzes
- Resources

Administration

- Turn editing on
- Settings
- Edit profile
- Teachers
- Students
- Groups
- Backup
- Restore
- Import course data
- Scales
- Grades
- Logs
- Files
- Help
- Teacher forum

Topic outline

LTT-1111 Course name

Instructions: (do not include to your course's page)

- Kurssipohjan asennusohjeet omalle kurssillesi
- Basic instructions to create a Moodle page

Course information

Course arrangements

- Course activities
- Course timetable

Course forums

- News forum
- Discussion forum

Questionnaires

- Preliminary Questionnaire Form
- Questionnaire about the course
- Questionnaire about Moodle

Feedback

- send e-mail: xx.xxx@tut.fi
- Glossary

1 Lecture 1: topic

- Info about the lecture, etc.
- Exercise 1
- Test quiz

2 Lecture 2: topic

3

Calendar

<< May 2007 >>

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5	
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

- Global events
- Group events
- Course events
- User events

Latest News

Add a new topic...
 (No news has been posted yet)

APPENDIX 7: Surveys to the teachers

Questionnaire of Moodle to teachers

1. How many virtual courses have you made of a virtual learning environment (VLE)?
 - a) 0
 - b) 1-2
 - c) 3-4
 - d) more than 4

2. How would you describe your teaching skill level of a VLE? [Korhonen]
 - a) Experienced teacher of VLE
 - b) Self-educated
 - c) Experimenter
 - d) Novice

3. Moodle is a useful part of teaching.
 - a) strongly agree
 - b) mostly agree
 - c) no opinion
 - d) mostly disagree
 - e) strongly disagree

4. Moodle is a good environment for interaction between students and teacher. (a-e)
5. Moodle is easy to use. (a-e)
6. Which is more time consuming traditional, contact teaching or teaching with learning environment?
 - a) traditional contact teaching
 - b) teaching with learning environment
 - c) no opinion

Why?

 - a) Open form

7. Would you like to have more guidance in using the Moodle?
 - a) No
 - b) Yes. How? About which features?

8. Which activities have you added to the courses?
 - g) lesson
 - h) forums
 - i) resources
 - j) assignment
 - k) calendar
 - l) quizzes
 - m) chat
 - n) dictionary
 - o) other (specify)

9. Which features did you find unnecessary?
 - a) Open form
10. What extra features would you add to Moodle?
 - a) Open form

Questionnaire in the end of a course to teachers

General

11. How much time did the following parts of teaching take in this course? Choose in numerical order, 1 being the most time consuming part.
 - a) Preparing the course material
 - b) Preparing the Moodle site for the course
 - c) Updating the Moodle site
 - d) Giving lectures
 - e) Giving exercises

Interaction skills

12. Do you have training for teaching?
 - a) I have taken a degree in teaching
 - b) I have taken some courses of teaching
 - c) Self-educated
 - d) No training
 - e) Other (specify)
13. How much do you know about teaching/ pedagogy?
 - a) a lot
 - b) some
 - c) not much
 - d) nothing
14. What is good about your interaction skills?
 - a) open field
15. What would you like to improve in your interaction skills?
 - a) open field

Content of the course

16. Did you have enough time to prepare the course material and lectures?
17. In your opinion, were you successful in presenting the main things of the course?

Learning guidance

18. Did you have enough time to guide the students?
 19. Which methods did you use to guide the students (tutoring hours, after lessons, etc.)?
- Presentation methods of the content of the course

20. Which methods of presenting the course material did you use (powerpoint-slides, transparencies)?
21. Was the method(s) the best and/or effective for this course?
22. How would you change the use of presentation methods in this course?

Moodle

23. How many virtual courses have you made of a virtual learning environment before this course?
 - a) 0
 - b) 1-2
 - c) 3-4
 - d) more than 4
24. Which activities of the Moodle did you use to present the course material?
 - a) Lesson
 - b) Presentation
 - c) Book
 - d) Resource
25. Which features of the Moodle did you use to present the exercises/ exercise work/ seminar?
 - a) Forum
 - b) Questionnaire
 - c) Assignment
 - d) Choice
 - e) Quiz
 - f) Workshop
 - g) Wiki
26. Did you use Moodle to do exercises/ exams during and after the course (which)?
27. What kind of different activities would you have added to this course's Moodle environment besides the existing ones?

Learning evaluation

28. Did you use exams / quizzes (e.g. in the beginning or the end of a lesson) during the course?
29. How did the exams / quizzes affect the learning results of the students?
30. Which methods did you use to follow/control students' learning (exam/ learning diary/ seminar/ work/ etc.)?
31. Was the previous choice adequate for this course?
 - o If not, why and how would you improve it next year?

Summary of the students' feedback